

The shaping of the landscape

The living countryside of the British Isles has evolved over millions of years, but the greatest single influence on the land has been man. It's this close relationship between man and nature that gives our landscape its particular quality.

Compared with many parts of the world, Britain's landscape seems undramatic at first—there are no deserts, no jungles, no savannahs. But anyone who takes the trouble will discover that our beautiful countryside is infinitely rich and varied. As you read about the multitude of plants and animals in the following pages you will come across references to the great forces that formed our landscape—the geological upheavals, the Great Ice Age, wind and weather, and of course man himself.

Man's influence If man and his grazing animals had never come to Britain, the land would still be covered in primeval forest with the occasional glint of lakes and rivers, and bald mountain tops jutting through upland conifers. But very early on men started to make clearings in the forest, chopping down trees, burning the undergrowth, planting crops. (Many moors and heaths, such as Dartmoor, are the result of clearances which started in the Bronze Age around 3000 years ago.) Sometime after 500BC man introduced domestic sheep and cattle, their tearing teeth and horny hooves preventing the regrowth of the natural forest. As the centuries passed man ploughed, drained bogs and marshes, planted hedges, built cities and towns-and over 5000 years re-arranged the landscape so entirely that only a few remnants of the really wild 'natural' Britain remain. In its place we have a remarkably beautiful country in which man and nature maintain a complex relationship.

Britain joined to Europe As recently as 7000 years ago, Britain and Ireland were still joined to the European mainland. As the last Ice Age retreated north 10,000 years ago, so plants, animals and men moved in from Europe. But as the ice melted, the sea level rose. First it cut off Ireland, which is why Irish plant and animal life is less varied than in Great Britain and why, for example, there are no moles there (they had not by then succeeded in spreading that far west. Then the



2000 1st ice age 700 warm period 430 2nd ice age 375 warm period 175 3rd ice age 125 warm period 70 last ice age warm period

The Great Ice Age is the name given to the several glacial periods-or ice ages-which have occurred in the last two million years. During each ice age, glaciers swept down from the north, gouging, scraping and flattening the rocks that form the backbone of our country. In the intervening warm periods animals and plants moved up again from the south even hippos and hyenas. As ice returned, the wildlife 'slate' was wiped clean.

(table in thousands of years) Britain becomes an island present day

The extent of the last ice age





Left: The Stiperstones in Shropshire are ancient outcrops of hard quartzite, more resistant to weathering than the softer rocks which surround them.

Below: Many flat farmland areas in Britain were once covered by seas. Others, like Grinshill in Shropshire, were flattened by glaciers and then covered in sand and gravel as the ice melted.

swampy areas of what is now the English Channel and the North Sea flooded, turning Britain into an island. Those species here before we became an island make up our native flora and fauna. These include most of our wild flowers, about three dozen trees and a wide range of animals. Thereafter, the only species that invaded from abroad were ones that could fly, drift across or were brought in by man, either on purpose (like pheasants) or unwittingly (like black rats).

Geological upheavals The geological foundations of Britain were laid down millions of years ago, then later modified and distorted by upheavals in the earth's crust, leaving a huge variety of different rocks, including granite, limestone, chalk and sandstone. We can still see these rock formations, from the ancient mountain of Suilven in Sutherland (1000 million years old) to the limestone pavements of Northern Ireland and York-

shire, or the rolling chalk Downs in the south of England. Different rocks produced different types of soil; and since what grows on top depends on what is underneath, the flora often gives us clues to the underlying structure of our landscape. The Living Countryside will show you how to recognise the rocks and soil of Britain, and how they influence the habitats associated with them.

Returning to the present Long-term geological processes continue subtly to reshape the landscape, while man brings about more rapid, and sometimes devastating, changes. Modern intensive farming means that thousands of miles of hedgerows have been grubbed out and age-old meadows, with their rare flowers and associate butterflies, have been ploughed up. On the positive side, more areas are being set up as nature reserves and national parks to protect them from harmful change in the future.



Seasons and cycles in nature

The Living Countryside shows you what to expect in the weeks to come, following Britain's seasons through their cycles of birth and renewal.

The changing seasons, the inevitable rhythm of night and day, the intricate webs of survival and interdependence—each has a profound effect on the wildlife of Britain.

The seasons Most plants and animals are sensitive to changes of daylight and temperature. These two key factors regulate their life cycles and habits, preparing them for the abundance of summer and rigours of winter. Longer hours of daylight and warmth in spring encourage many flowers to open when insects are around to pollinate them. These same triggers make insect eggs hatch and prompt birds and mammals to moult at appropriate times of year, ensuring that a thick coat is present before the arrival of winter and shed again before summer comes. Shorter days and colder weather signal to swallows, for example, that it is time to migrate. Hibernators are forewarned of winter and begin to accumulate food stores or fat.

A delicate balance The countryside depends for its survival on a delicately balanced pattern of life and death. Natural disasters such as the drought of 1976 can affect this precarious cycle drastically (many trees died as a result). When man interferes, he threatens this balance too.

As you look at the simplified food chain illustrated on the right, imagine how even more widespread use of pesticides would affect those birds which feed on insects; how diseases such as myxomatosis (introduced by man) affect not only rabbits but also the animals that depend on them for food.

The Living Countryside aims to keep abreast of these changes, explaining and anticipating the natural events around us. But bear in mind that Great Britain is over 700 miles long, so the precise timing of seasonal events varies from one area to another. Years vary too; in warmer years spring may come early, for example. This all helps to add interest and excitement to the natural history of Britain, making this one of the most fascinatingly varied parts of the world to live in. It also means that exact dates cannot be attached to the seasons, so where months are given in The Living Countryside they are only approximations.



Winter Broadleaved trees lose leaves before winter. Otherwise water would be lost through the leaves at times when the soil may be frozen and fresh supplies of water cannot be taken up by the roots. Frost and rain help to break down the leaf litter, returning nutrients such as nitrates to the soil.



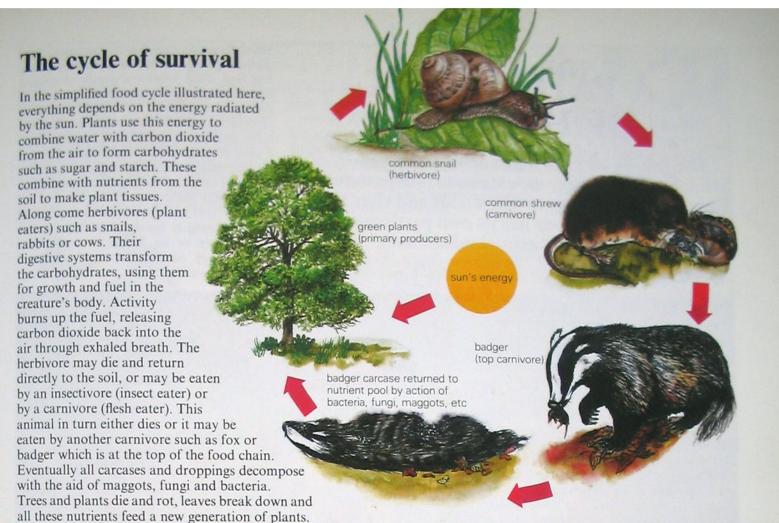
Spring Many woodland plants, such as bluebells and primroses, flower early before the tree canopy blankets them in shade. Hours of daylight are longer in spring (eight hours in mid-December, 13½ hours by mid-April) and this photo-periodic (light-time) switch triggers plants into flowering and trees into unfurling their leaves.

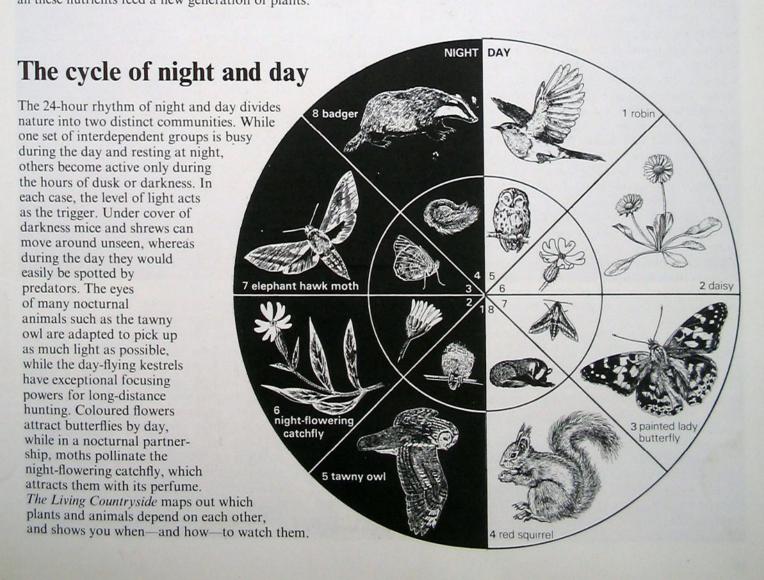


Summer The warmth of summer ensures that plenty of insects are available for birds, such as this skylark, to feed to their young. Long summer days (17 hours in mid-June) provide more time for birds to forage supplies for the extra mouths. But an early dry spell can mean a disastrous drop in numbers of insects—and so fewer chick survivors.



Autumn Small mammals, like this bank vole, are most numerous in early autumn. But once the glut of berries, nuts and seeds is over there is too little food for all to survive, and within a few weeks the population may be halved. Only the fittest survive the rigours of winter.



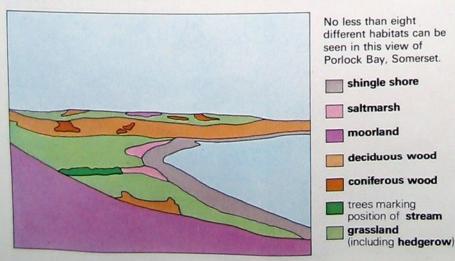


A PATCHWORK OF HABITATS

The British Isles are made up of a rich variety of habitats—from craggy mountains to lush pasture land, from heaths and bogs to oak woods and river banks. Discover how each one has its own particular group of plant and animal inhabitants.

Habitats are recognisable environments where distinct groups of plants and animals live and feed. Each habitat is usually associated with a particular set of soil and water conditions. For example, in a coastal sand dune habitat you should find marram grass, sea holly and sea spurge plants, together with typical nesting birds such as terns and ringed plovers. But you wouldn't expect to see bluebells and oak trees on these mounds of salty, calcium-rich shifting sand: they are just too dry, salty and wind-blown for most plants to live on. Similarly woodpeckers and roe deer are unlikely to be found in sand dunes because they need the trees of woodland habitats to survive.





Very often when you go for a walk you can spot a number of different habitats within close range, one merging into the other. In the view above, patches of coniferous plantation are dotted among large areas of deciduous woodland on the far hill. Strips of hedgerow, harbouring hundreds of insects, birds and mammals, divide up the farmland. A large ridge of unstable shingle sweeps round the bay. At the mouth of a stream is a patch of saltmarsh where a group of specialized plants and animals withstand the salty conditions. On the windy hilltops in the foreground, the moorland is dominated by heather, gorse and bracken all of which thrive in this type of habitat.



Where man meets nature

Over three quarters of the land in the British Isles is devoted to agriculture. Here areas such as hedgerows, cornfields and meadows with grazing animals, each constitute a form of habitat. As with natural habitats, the combination of climate and soil produces a definite pattern for man-made farmland. Some areas are mainly concerned with arable farming (cereal and fodder crops), some with horticulture (fruit and vegetables), while others—usually the wetter places—are devoted to livestock rearing (sheep, beef and dairy cattle). During the weeks to come, The Living Country-side will explore what goes on in today's farming landscape.

Although farmland is a man-made habitat, it is still often the home of a rich assortment of wild plants and animals. As you look more closely, for example, you can recognise pasture meadows in spring and summer by the wide variety of wild flowers growing in them; planted grass fields have fewer species. Even in areas of intensive arable farming, wildlife still survives in the patches of semi-natural vegetation between crop fields and in odd corners into which bulky farm machinery cannot reach. Some species, like the black headed gulls shown below, actually move in to take advantage of man's reshaping of the land. When fields are ploughed the birds gain access

to a new source of food they could not have had without man's help.

However, farming also poses serious threats to wildlife. Natural habitats contain a multitude of varied plants and animal species, all doing their own thing for their own benefit. But with agricultural land all the sun's energy and the soil's nutrients, that are shared out among the species in a natural habitat, are directed to growing food.

Intruding plants are weeds, any herbivore that treats the crop as though it were its customary food plant is destroyed as a pest. Natural cycles are modified or disrupted. Ploughs assault the land, while grazing, fertilizers and chemicals all have dramatic effects too. Of course it has to be this way in order to feed our own species. Similarly, urbanisation and pollution—to a certain extent necessary evils in a densely populated industrial country like Britain—affect wildlife adversely. All the more reason for us all to understand what is going on in the environment and to watch out for the possible consequences.

The Living Countryside will explain the complex—and at times strained—relationship between man and nature, not only in this habitat but in many others as well. With this publication you will be able to assess what needs to be conserved and how to set about it.



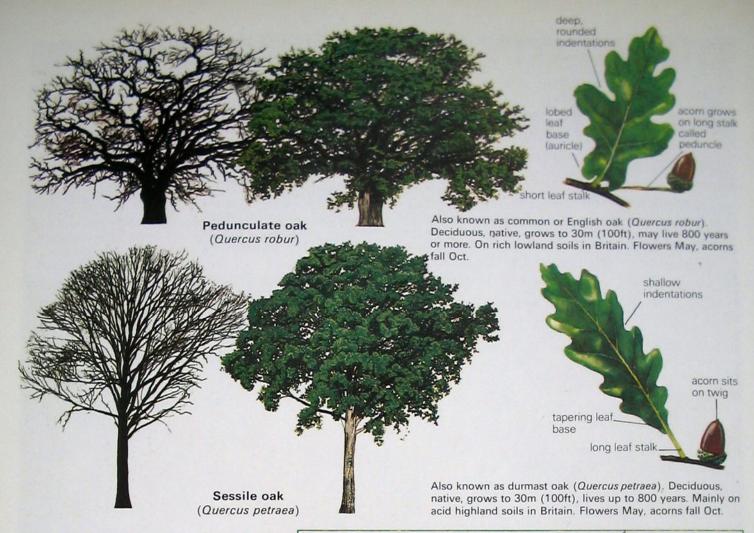
THE MIGHTY OAKS OF BRITAIN

Oak trees live longer than all other native trees and support a greater variety of wildlife than any other species in our islands. Even when they die, they still give food and protection.

From the top of its spreading crown to the ends of its roots, which can extend as far below the ground as its branches reach into the sky, the oak tree provides shelter and food for hundreds of different organisms. Like a crowded highrise block, the oak is inhabited at every level: birds and squirrels build nests in the crown, insects such as wasps, moths, beetles and weevils devour the leaves; ivy, mistletoe, lichens, mosses, algae and fungi invade the branches and bark; birds, insects and mammals feed on the acorns. Even the roots of the young oak are sought out by such insects as weevils and, as the oak lets in quite a lot of light through its leaves, flowering plants grow underneath it.

Below: Oak trees make up one tenth of all English woods. A fine specimen like this pedunculate oak may take up to 100 years to mature.





You may think that the oak must be quickly overpowered by this invasion of wildlife, but once a sapling becomes established the oak can live for up to 800 years, continuing to act as host to this multitude of creatures. In fact the oak has adapted itself so successfully in temperate regions that there are over 450 different species of oak in the world. Several of these oaks grow in Britain and Ireland, but only two, the pedunculate (also known as the common or English oak) and the sessile (durmast) oak are native to our islands. It is not always easy to tell the difference between them.

When it is growing in the open, the pedunculate oak is gnarled and tends to have lower, more horizontal and wider-spreading branches, so that the main trunk is hidden beneath a mass of boughs and leaves. The sessile oak has a straighter, less gnarled trunk, with branches growing from higher up.

You are likely to come across woods where both species of oak are growing, often among other trees. The huge forests of Epping and the New Forest are typical of such mixed woods. Here it is more difficult to distinguish the two species. For example, when the pedunculate oak competes for light with other trees it may lose some of its broad shape. To make it even more confusing, one species is frequently fertilized by the other and the result is a hybrid with characteristics of both species.

Close up If you get close to a true sessile or

Native or introduced?

Among the scores of different trees seen in Britain today only 35, including the sessile and pedunculate oaks, are native species (right), ie they spread into this country naturally, without the assistance of man. This was possible at the end of the last Ice Age—about 10,000 years ago—because at that time Britain still formed part of the European land mass.

To begin with only the hardiest plants, such as mosses and bilberry bushes could survive. But as the climate grew warmer trees like hazel, Scots pine, birch, elm and later oak established themselves.

Then about 7000 years ago Britain was separated from the rest of Europe. Melting glaciers caused the sea level to rise, flooding what is now the North Sea and English Channel. This watery barrier prevented further natural invasion by non-waterborne plants such as trees. So the trees that had managed to reach Britain by that time are our 35 native species.

The majority of different types now in Britain were introduced by man because they were useful or ornamental. When the Roman legionnaires settled here they brought the edible sweet chestnut. Remains of walnut trees have also been found in Roman villas. The Norway spruce, the familiar Christmas tree, arrived in the 16th century and the handsome cedar of Lebanon and the horse chestnut in the 17th century.

COMMON NATIVE TREES

Aspen (Populus tremula) Bay willow (Salix pentandra) Bird cherry (Prunus padus) Black poplar (Populus nigra) Box (Buxux sempervirens) Common alder (Alnus glutinosa) Common ash (Fraxinus excelsior) Common beech (Fagus sylvatica) Common pear (Pyrus communis) Common yew (Taxus baccata) Crab apple (Malus sylvestris) Crack willow (Salix fragilis)
Downy birch (Betula pubescens) Field maple (Acer campestre) Goat willow (Salix caprea) Grey poplar (Populus canescens) Grey willow (Salix cinerea) Hawthorn (Crataegus monogyna) Hazel (Corylus avellana) Holly (Ilex aquifolium) Hornbeam (Carpinus betulus) Juniper (Juniperus communis) Midland hawthorn (Crataegus laevigata)

laevigata)
Pedunculate oak (Quercus robur)
Rowan (Sorbus aucuparia)
Scots pine (Pinus sylvestris)
Sessile oak (Quercus petraea)
Silver birch (Betula pendula)
Small-leaved lime (Tilia cordata)
Strawberry tree (Arbutus unedo)
Whitebeam (Sorbus aria)
White willow (Salix alba)
Wild cherry (Prunus avium)
Wild service tree (Sorbus torminalis)
Wych elm (Ulmus glabra)

pedunculate oak, however, you should be able to tell them apart quite easily.

The leaves of the pedunculate oak are pale green and virtually hairless, with two obvious 'ear-lobes' (auricles) at the base. They have deep, rounded indentations all round. In autumn, acorns grow on long stalks called peduncles—hence its name.

The leaves of the sessile oak are dark green, have no auricles and the indentations are not so deep. Leaves grow on long stalks and have a few hairs on the midrib of the underside. Unlike the pedunculate, the sessile acorns sit

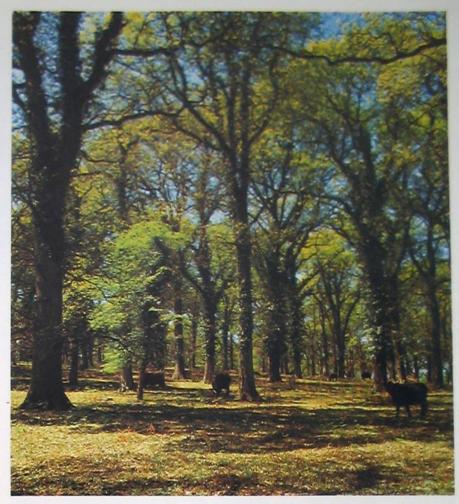
on the twig.

Pedunculate oak woodlands are the most common, and are usually found on heavy clay soils throughout lowland Britain. The pedunculate oaks at Bagshot Sands in Berkshire and Hovingham, North Yorkshire, are well worth a visit. Sessile woodlands are found in the highland areas of Britain and usually occur on shallow acid soils. The Birkrigg and Keskadale oaks south west of Keswick in the Lake District are excellent examples of 'pure' sessile woodlands.

Acorn bonanza Trees are flowering plants but many of their flowers are not spectacular, large or colourful and the oaks are no exception. Inconspicuous female catkins (flowers) are pollinated by the wind-carried pollen grains from male catkins (so large petals needed to attract insects for pollination are unnecessary). The oak's acorn crop varies from year to year-in a bumper year each tree can produce as many as 50,000 acorns. But few of the hundreds of thousands that fall every year grow into full-sized trees. Acorns start to form in early summer (the warmer the summer the larger the acorns), and then during a few weeks of early autumn they fall to form a dense carpet. They do not stay long on the ground for they are seized by hordes of birds and animals, either to be eaten or stored away for the winter. Jays and squirrels in particular bury them (sometimes quite a distance from the wood) and then forget about them. This is one of the ways the oak is spread across the countryside.

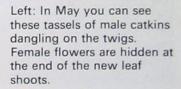
Valuable tree Oak woods covered much of Britain in medieval times and our ancestors quickly discovered that oak made good fuel. The sessile oak was also valued for its acorns. From the Middle Ages until the 18th century people drove their pigs into the oak woods on common land to feed on the abundant acorns. Indeed, one way of assessing and comparing the size of each manor's forest was to count the number of grazing pigs that could be supported. Such grazing rights still exist today in the New Forest in Hampshire.

Oak wood was used extensively for shipbuilding and many parks, such as Regents Park and Greenwich Park in London, were planted especially to supply the Royal and Merchant navies. Oak wood was used extensively for supporting beams in country cottages and is still used by builders today.





Above: Woods often contain both pedunculate and sessile oak trees, in which case it is often difficult to distinguish between the trees by shape alone. Closer inspection is necessary for identification.





Left: Acorns fall in autumn and germinate if kept moist, not producing leaves until the spring. Seedlings grow 15cm (6in) in six months.

The brimstone (Gonepteryx rhamni) is the butter-yellow herald of spring and its colour is thought to have given us the word 'butter' fly. Its wingspan is 5cm (2in); the food plant is buckthorn. Its life cycle is: eggs May-July; caterpillar June-early August; chrysalis July-August; adult July onwards.







The small tortoiseshell (Aglais urticae) after the nectar in an ice plant (above). This butterfly is widespread and common in gardens and other habitats, although less so in northern areas and in Ireland. Its wingspan is 5 cm (2in); the food plant is the stinging nettle. The autumn brood may hibernate in, for example, a shed roof (right). The underside of its wings gives the appearance of dead leaves, wood or bark.



SLEEPING BEAUTIES

The cold weather of winter poses a major problem to many creatures and butterflies are no exception. Depending on the species, they hibernate, migrate or die. The peacock, small tortoiseshell and brimstone butterflies are three which opt for hibernation.

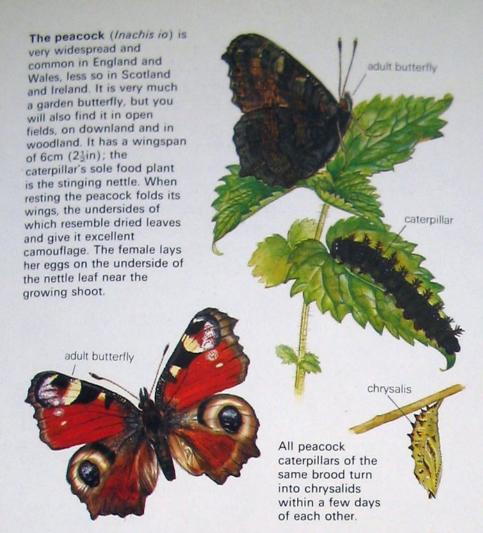
The beautiful peacock and small tortoiseshell butterflies that feed on Michelmas daisies in autumn gardens are the same butterflies that will be out and about searching for flowers on the first sunny, warm day of the new year. The peacock and small tortoiseshell are usually up and about in March, while the brimstone, which favours the flowers of the woodland rides, can often be seen much earlier particularly in the south of England—even in January if the weather is suitable.

These butterflies live for about nine months in their adult stage, much of this time spent in hibernating sleep. Other butterflies have different methods of coping with winter: a few migrate to warmer climates where nectar is available, while others survive the winter in the inactive egg or chrysalis stage or hibernate in the caterpillar stage.

Butterflies need the sweet energy-rich nectar from flowers to give them strength to fly and help them survive their hibernation through the long winter months. During this inactive state their energy consumption is minimal, so they can survive without further food. As a protection against the cold, some sugar in their blood is converted to glycerol which works rather like anti-freeze in car radiators.

Hibernating time In late autumn the peacocks, small tortoiseshells and brimstones search for a safe, dry, dark place where they will be protected from winter frosts. Usually peacocks find a hollow tree, although they will sometimes tuck themselves in a wood pile or a corner of a garden shed. Small tortoiseshells choose similar places, but are also quite likely to come indoors. A hideaway behind a picture in a little-used room is safer than a hollow tree: there are no birds to eat them while they sleep. Brimstones seek dense, evergreen cover in their woodland surroundings—and particularly thick growths of ivy or holly which offer protection.

The butterflies often bury themselves among dead leaves. At rest, the bright wing colours are hidden; only the underside, looking like a dried-up leaf, is visible. This gives



the butterflies particularly good camouflage.

The peacock has a spectacular defence mechanism which it uses if it is disturbed from rest. Opening its wings, it creates an alarming hissing noise as the front and hind wings rub across each other, revealing huge 'eye-spots'. A small bird, startled by the hiss and then confronted by large owl-like eyes, will usually fly off, leaving the butterfly to go back to sleep.

With the first spring sunshine in late March the peacocks and tortoiseshells awake from hibernation; individual peacocks can be seen much earlier in fine weather, when they come out for a short flight. Although the brimstones may be tempted to stir as early as January, they return to hibernate until later. Sometimes tortoiseshells hibernating indoors also wake too early, perhaps because the heating is switched on in a spare bedroom. If you see a tortoiseshell fluttering at a window in midwinter, put it in a cool shed or garage where it can go back to sleep until spring really arrives. There are small migrations of tortoiseshells from abroad which augment our own butterflies.

The new brood of adult brimstones emerges in July and August and spends most of the day feeding. It shows a distinct preference for purple flowers, particularly those of the thistle, knapweed, scabious, bramble and clover. The new brood of adult tortoiseshells, which emerges in late June or July, lays eggs to



The brimstone caterpillar eats the leaves of the food plant—buckthorn.



The small tortoiseshell caterpillar feeds on the same plant as the peacock.

produce a second brood in August and September; this feeds on most garden flowers, especially ice plant and buddleia, and is the overwintering brood. The peacocks emerge later—in August—and are numerous in gardens where they feed on buddleia and in fields where they feed on lucerne, thistle, knapweed, marjoram and clover.

Remember that you need more than flowers to attract butterflies to your garden. An undisturbed corner of a shed will give the butterflies somewhere safe to hibernate and a patch of nettles in a sunny corner of the garden will feed the caterpillars which will turn into chrysalids and eventually become the next generation of butterflies.

Life cycle of peacocks and small tortoiseshells

Butterflies go through four stages: the egg, the rapidly feeding and growing caterpillar, the chrysalis and the adult butterfly. A peacock takes one year to complete a cycle but the small tortoiseshell caterpillar has less growing to do and there is time for two broods each year. The summer brood lives only a few weeks as butterflies.

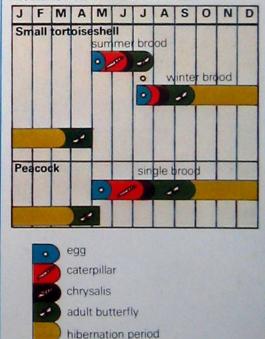
Egg After feeding for a few days from spring flowers, peacocks and tortoiseshells mate and then the females search for stinging nettles on which to lay eggs.

Caterpillar When the eggs hatch, the crowd of young caterpillars spin a single silk tent in which they all live as they feed and grow.

Chrysalis The fully grown caterpillars crawl away to find a fence or branch from which they can hang down while they turn into chrysalids.

Butterfly Within a few weeks the glistening adult emerges fully grown. The butterflies die several weeks after mating and laying their eggs.

MONTHS JANUARY-DECEMBER





Badgers have been described as the oldest land-owners in Britain. There is little doubt that long before Britain was an island they were here rooting among the vegetation of ancient deciduous forests. They belong to the family of mammals that have musk-bearing scent glands under their tails: these are chiefly carnivorous and including the otter, polecat, stoat, weasel and pine marten.

Many millions of years ago the earliest forms of this family group were rather simple land-dwellers, but they have gradually become adapted to their different ways of life and habitats. Thus the otter has become an accomplished swimmer and the pine marten a trapeze artist; the polecat, stoat and weasel are streamlined for speed and the badger has become a skilful excavator.

You can tell from its appearance that the badger is a digger. Its body is wedge-shaped and carried rather low on the ground on short but immensely strong legs—excellent for working in confined spaces. The muscles of the forelimbs and neck are particularly well developed and the five claws on each foot are long, especially those on the front ones.

The badger's digging activity is geared to enlarging and improving its home: a large underground burrow system called a sett, which consists of several sizeable chambers where the badger sleeps and breeds and a few smaller ones which sometimes serve as latrines. These chambers are linked by a complex network of tunnels.

When enlarging one of its tunnels a badger will loosen the earth with rapid strokes of its forelimbs, using its claws as rakes and for winkling out stones. The loose earth collects under its body, but by arching its back it is able to bring its hind limbs forewards to sweep the earth backwards. When enough soil has collected behind it, it moves backwards in a series of jerks, partly using its bottom as a bulldozer and partly hugging the soil between its forelegs and body. If you stand by an exit hole when a badger is digging you may be showered with earth and stones as it emerges backwards and gives a few last vigorous kicks before returning for another load.

As well as a home improver, the badger is also a tidy housekeeper and will spend a lot of time transporting grass, straw, moss or bracken to and from its sleeping chamber. Setts are handed down like family houses, from generation to generation, and the badger uses the same sett year after year. So regular airing of the bedding is vital as a safeguard against parasites (the scourge of all animals living a settled existence) and to prevent damp, cold conditions—especially harmful to young cubs.

Locating the sett A mild day in early spring is a good time to start looking for a badger community, although it is very unlikely that you will see a badger itself in broad daylight. Woods, copses and hedgerows are the most usual locations for setts, especially if these are





Above: Badgers usually have a black and white face and a grey body, although their fur is often stained yellow or reddish by the local soil.

on slopes bordering pastures. Here the badger can make its home where there is adequate cover and plenty of food in the vicinity.

Alders are often associated with badger setts, so look for patches of these trees. Elders will also grow near setts because badgers eat the berries and pass the seeds unharmed through their guts before depositing them in the droppings near their sett. Here the seeds will germinate and eventually become bushes or trees.

A well-established sett is unmistakeable. It will normally have anything from three to 10 entrances and a few have been found with more than 50. These entrances and exits are at least 25cm (10in) wide, much larger than rabbit holes. Outside each entrance is a large pile of earth which includes dried plant material such as hay or straw. This is old bedding which has been discarded. You will usually see a latrine close to an entrance, too. Near a main entrance you may see a tree, often an elder, with mud marks and scratches on it up to a height of about one metre. If you watch at dusk you may see a badger approach such a tree, raise itself on its hind legs, reach up with its forepaws and slowly drag these down the bark. Zoologists still don't know if the badger is merely stretching its limbs or perhaps marking a territory with its own particular scent.

Well-worn paths lead from the sett in

Left: A sow bringing back bedding straw. As many as 30 bundles may be collected on a dry night to furnish the underground chambers used for sleeping and breeding.

BADGER (Meles meles)
Also called brock
Size of adult heaviest in
autumn, lightest in spring
Male 11.6kg (25½b) Female
10.1kg (23⅓lb). Average
length of male 90cm (3ft)
including tail. Female slightly
smaller

Colour grey, rarely pale reddish, albino or blackish Breeding season young usually born mid-Jan to mid-March

March Gestation period 7-8 weeks of 'true gestation' preceded by a variable period of delayed implantation (2-10 months) Number of young 1-5, average about 3. During first 8 weeks may reduce to 2 Lifespan Average 2-3 years, max about 15 in the wild Food diet very variable, but earthworms by far the most important. Also insects (esp. beetles), small mammals, carrion, cereals, fruit Predators adults seldom killed by predator, cubs occasionally killed by dogs and foxes. Many killed by gamekeepers and farmers Distribution widespread. More in wild, wet areas of south and west, fewer in flat, heavily farmed areas, and

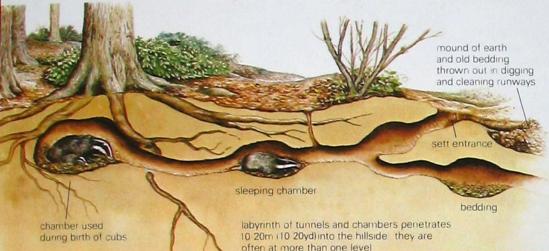
above 900m (1200ft)

The badger's sett

In most setts badgers use only one chamber for breeding. Here the cubs will stay bedded down in a mass of hay or bracken. The sow will suckle them there but may sleep in a nearby chamber. Others in the group will often cuddle up in another chamber.

Badgers will enlarge some of the tunnels every few metres to form passing places. Tunnels can go as deep as 4m (13ft) but most are less than 1m (3ft) underground and often follow the contours of the surface. This allows better circulation of air. Ventilation holes sometimes connect a tunnel with the outside, but whether by design or accident is not known.





Above: The entrance to a sett; if you see one, check around for others. The entrance looks rather like a fox hole, but badgers scratch the earth away to a large heap nearby, leaving a furrowed track from the hole.

A motorway underpass built for badgers

A tunnel purpose built for badgers, to prevent them from being run over by busy traffic, was constructed in 1976 under the M5 motorway near Wellington, Somerset, where it intersected a badger path leading from the sett to feeding grounds

Although specially designed to save badgers lives and to prevent accidents, this safe, underground route did not seem to be able to lure the badgers—despite the use of bait to attract them, and such ingenious methods as a man with badger's scent on his coat crawling through the tunnel

Only when the rearing of cubs made them seek larger food supplies did the badgers 'officially open' the site in 1979 and claim the territory with the placing of latrines at either end

various directions, joining one entrance to another and also leading off to different parts of the badgers' territory. It is interesting to map this system of paths, which alters little from year to year. Although visible to us these paths are really scent trails, since all the badgers using them mark them periodically with their own scent. Unfortunately some of these paths, which have been used by badgers for generations, are now crossed by roads and many badgers are run over by passing traffic.

Signs of foraging Look out for signs near the sett where the badgers have been foraging. You may see dead leaves disturbed where badgers have been rooting or shallow pits dug when they have been seeking out some beetle or earthworm. The corms (underground stems) of lords-and-ladies are favourites at this time of year; badgers bite off the poisonous yellow shoots and eat the succulent underground corms.

But what goes on in the depths of a sett? A large, well-established sett in the Cotswolds which was given a thorough survey had 12 exit holes and a maze of tunnels and chambers totalling 310m (1000ft). From the length and diameter of the tunnels it was estimated that over the years the badgers had excavated 25 tonnes of soil.

Birth of the cubs If you notice a spurt of digging activity in late December or in January and, if the weather is dry, some fresh grass or bracken dropped near an entrance. you can be fairly certain that the birth of cubs is imminent and the breeding chamber is likely to be quite near that hole.

Bedding is also of great importance for the survival of the cubs as a chamber full of hay, straw and bracken will act as an insulator, helping the cubs conserve their body heat. For the first few weeks after birth they lie in this cosy nest and are suckled when the sow (female) returns from foraging trips.

The gathering of bedding is an interesting manoeuvre. The badger collects up bundles of dry vegetation, scraping the pieces together with its claws and biting off tough stalks with its teeth. Hugging each bundle in turn to its chest and using its chin and forelegs to keep it in place, it shuffles backwards towards the sett, eventually disappearing down the tunnel tail first.

Usually cubs are born during the first fortnight in February in the south and west, rather later as you go north. They are covered in grey silky hairs and already the dark facial stripes are visible. They are about 12cm (5in) long and weigh about 100g (3½oz). Their eyes are closed for about five weeks, but before long they are ready to explore the tunnels.

Mating period The first three months of the year are a busy and exciting time for the badger community. Soon after the birth of the cubs, most sows become ready to mate again and yearling females may come 'on heat' for the first time at this season. So mating can be

a conspicuous feature to watch out for at this time of year.

The dominant boar (male) usually occupies a part of the sett well away from where the sow has her cubs; and she will drive him off if he attempts to approach her litter. The boar's behaviour at this time is largely concerned with mating, territorial defence and feeding. On some evenings he will emerge early and visit the various sett entrances, sniffing and making a deep whinnying purr. If a sow emerges and is on heat he will mate with her. Mating can last half an hour and may be repeated over several nights.

At other times the boar may quickly leave the sett and follow one of the main tracks to the limit of territory owned by his social group. Here he will scent-mark the boundary with droppings, using latrines strategically placed to warn off intruders. He may also patrol the perimeter of the territory and if necessary fight with any trespassing badger.

Meanwhile the sow makes short foraging excursions nearer to home to find food for herself and to build herself up for suckling the cubs. On wet nights, earthworms will be the main source of food, but many other creatures will be taken including the occasional dead bird and any early litter of young rabbits she smells and digs out.

The cubs are weaned in summer and start to venture above ground to feed and play—so summer is a good time to watch badgers.







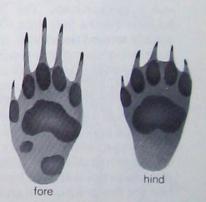
Watching badgers

Find the tell-tale signs of a badger sett, such as piles of discarded bedding straw and latrines, and you will soon discover badgers. To check if the sett is occupied, place a thorny bramble firmly inside the entrance and look next day to see if any black and white hairs are snagged on to the thorns. You may also notice hairs caught on barbed wire fences in the area (below left) badger footprints in the earth (below) or claw marks on nearby trees (left).

Watch for badgers from a well-concealed spot upwind from the sett or they will catch your scent; the best time is sunrise or at dusk. You may tempt them out with meat scraps or a bone near the hole. If badgers accept your offering, they may come back for more.



Above: Two well-grown cubs. The number in a litter varies from one to five, but two or three is most usual. Cubs are nearly always born in early February.



Above: On each foot the badger has five toes with strong claws. The claws on the forefeet are longer than those on the hind, which are often worn down by constant digging. Badgers tread heavily, but even so only four of the five toe pads may show up clearly in a track.

WINTER **FLOWERS**

The greys and browns of the winter landscape epitomise the bleakest time of the year in terms of nature. But a few flowering plants flourish despite the conditions and introduce a much needed splash of colour. Why do they come out now and how do they survive?

It is very unusual in the plant world for flowers to bloom only in the middle of winter. Out of about 2,000 species of flowering plants native to the British Isles, only a couple of dozen have a true flowering season in January and February.

Some plants will flower spasmodically all year round given favourable weather conditions -plants like shepherd's purse, chickweed and Persian speedwell-but their peak comes in the warmer months when they are growing most vigorously. To most people the true winter flowers are the snowdrop and the winter aconite: the first obvious flowers of the new year, they provide a very welcome sight.

Snowdrops begin to flower as early as Christmas in a mild winter, but if it is very cold they will wait until well into March. They were once rare in Britain, found only in the damp woods of western England, but today they are much more widespread, probably having escaped from gardens into surrounding woods. The flowers close at night and when they open the next morning, usually around ten o'clock, the petals start to ooze out nectar. If you touch the tip of your tongue inside a snowdrop after it has been open for a few hours it tastes slightly sweet. Because the petals droop the nectar is protected from rain. The flower is a powerful attraction to the few early insects about at this time of year. Honey bees are sometimes seen to land on one of the spreading sepals and, by clinging to this with their hind legs, they delve into the flower for pollen and nectar.

Spring snowflakes are rare relatives of the snowdrop and they too are more often found as a garden escape than as a true descendant of plants of our primeval forest. Similar to a large, robust snowdrop, the spring snowflake is easily recognised by its bell-shaped flowers with green tips to the petals. They come out a little later than snowdrops and are sometimes produced in pairs on the stem.

Winter aconites come into flower at about the same time as snowdrops, their flowers expanding in sunny weather to reveal curious tubular petals which again hold droplets of nectar. Each flower is surrounded by a leaf-



Above: The first vellow flower of the new year, the winter aconite opens its shiny sepals in the sun when the temperature reaches 10°C (50°F).

Structure of flowers

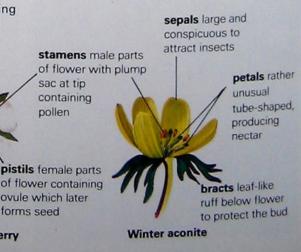
The first job of any flower is to produce seeds, which it usually does by attracting insects for pollination. The barren strawberry has a simple flower structure and insects are drawn to the nectary within the flower. The winter aconite is one of many variations on this theme: its sepals, resembling petals, attract insects, and the petals have evolved into nectar cups.

sepals green,. resembling small leaves, protect bud before flower opens

petals conspicuous, often with faint lines to direct insects like ruff, but the true leaves, which are highly poisonous, emerge from the ground only after the flowers have withered. Introduced from Southern Europe 400 years ago, the winter aconite has become widely naturalised.

Barren strawberry By far the commonest of our winter flowers, if not the most spectacular, is the barren strawberry, so called because it superficially resembles the true strawberry, but its fruit is hard and inedible. It too produces nectar (from a small five-sided nectary, a pad between its stamens and ovaries) and this is drunk by flies and beetles and even the occasional small tortoiseshell butterfly that has woken early from its hibernating sleep.

Winter survivors Most plants are dormant



Barren strawberry

pollen

forms seed

in mid-winter and wait until later to flower. when pollinating insects are abundant and the milder weather encourages growth. Although winter flowers have a monopoly of any insect such as bees or flies that may be about, this is scarcely sufficient reason to flower now.

So why do these particular plants expose their flowers to the rigours of winter? Partly it is because they do not depend entirely on insect pollination for reproduction and each plant can be fertilized by its own pollen. They also have root structures which can multiply and produce new plants. (Winter aconites have tubers, snowdrops and snowflakes have bulbs, and barren strawberries have runners.) However, plants only 'improve their stock' if one flower is fertilized by the pollen of another, and with both these 'do-it-yourself' methods of reproduction the new plant is usually identical to the parent. If crosspollinated, the next generation turns out slightly different from the parents, and consequently some plants are perhaps better adapted to their environment.

The original environment of these plants may be another clue to their winter flowering. They occurred in the woodland which once covered Britain and Europe and adapted to this habitat by growing and flowering early in the year before the trees cut out their light. The temperature of woodland soil is considerably higher than that of the surrounding exposed land, and moss and dead leaves also acts as insulation.

Anti-freeze or central heating? For years botanists have been researching ways in which some plants survive intense cold. In some species flower buds as much as five degrees warmer than the surrounding air have been recorded and you may notice places where plants have melted the snow immediately around them. These higher temperatures are generated by rapidly growing plant tissues although if the plant were to keep up these growth rates to withstand a prolonged frost it would quickly use up its food reserves and starve.

> Barren strawberry (Potentilla

> Feb-May in open woods.

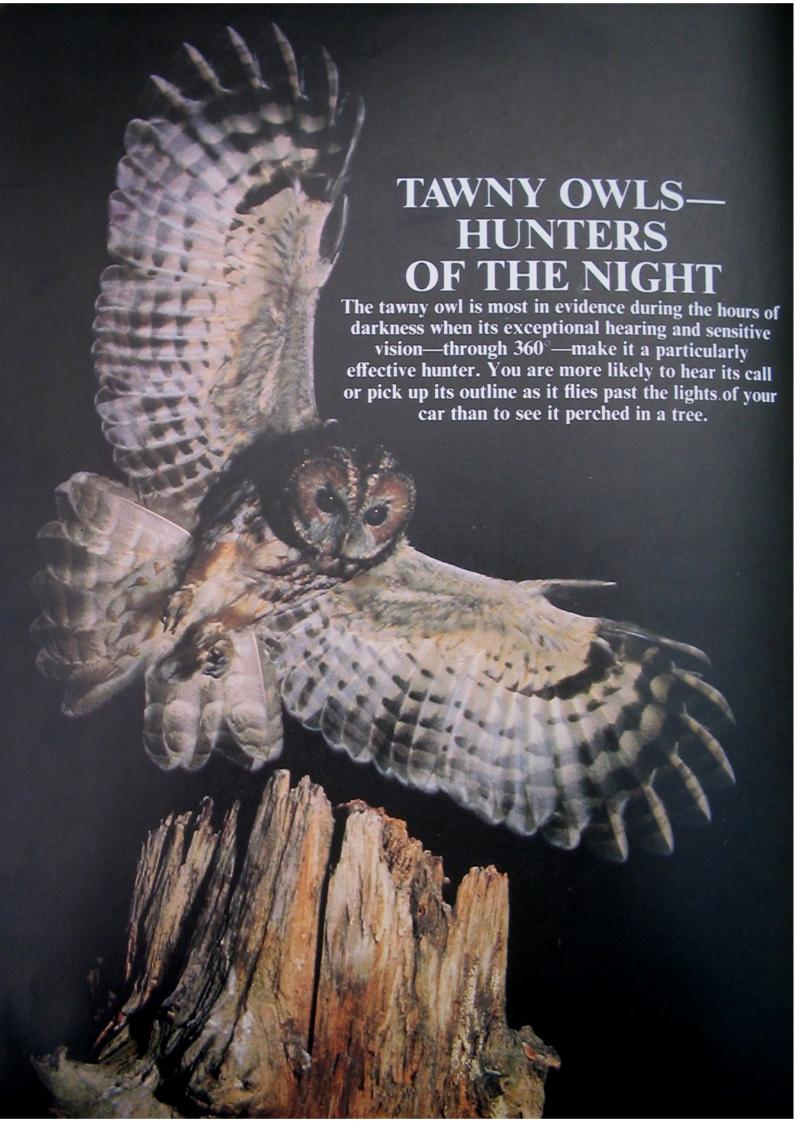
Some plants, such as garden dahlias, die immediately there is a frost while hardy plants such as snowdrops can freeze solid and then recover when they thaw. They do this by closing up to protect the reproductive parts and withdrawing water from their cell structure into the minute intervening air spaces.

Although not flowering as early as the winter flowers, the early dog violet (below left) and ground ivy (below centre) soon follow them in March.



hedges, open ground. Ht. 25cm (10in)

11



Tawny owls are highly specialised nocturnal hunters. Although the head may seem disproportionately big, inside the skull are two large, asymmetrical ears so sensitive that they can pick up the rustling and high-pitched squeaks of nearby prey after dark. They can pinpoint a moving target like a mouse with such accuracy that a miss is rare. In addition owls have unusually large eyes. These are forward-facing like human eyes and binoculars for three dimensional vision, which enables owls to judge distance accurately (Most birds have eyes on the sides of their heads.) The retina of each eye is extremely sensitive to light and so designed to enable the owl to see in very poor light

The owl can turn its head both left and right (like a radar scanner) to inspect a full 360, so the bird can search for and locate its prey while keeping its body still. The 'facial disc' of rather stiff, bristly feathers serves as a reflector, collecting sounds and focusing them on

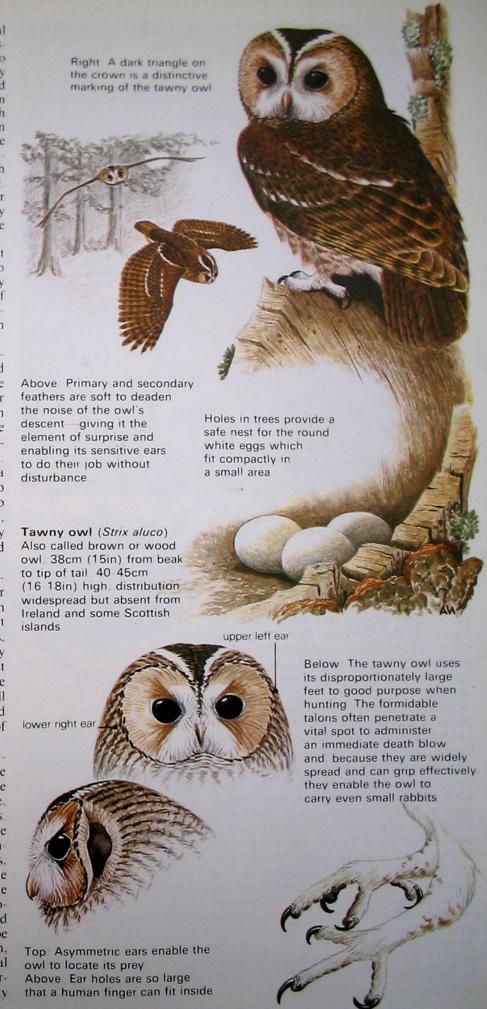
the ears.

Silent hunter The essence of effective nocturnal hunting is the silent approach and again, in the tawny owl, evolution has come up with the necessary adaptations. The outer surfaces of the feathers have a velvety finish to deaden noise, and the feathers of the leading edge of the wing have a special comblike fringe to silence the wing as it cuts the air.

Tawny owls will usually sit motionless on a branch, waiting for some unwitting meal to pass below. The owl then drops silently on to its victim, seizing it in the fierce grip of large, sharp talons. If this does not kill the prey instantly, the death blow may be administered by a sharp bite at the base of the skull.

In flight, tawny owls seem dumpy and topheavy with broad, rounded wings and rather moth-like, fluttering wingbeats. They often appear misleadingly pale in car headlight beams but, when seen in daylight, the blacks, browns, buffs and chestnuts of their streaky plumage provide excellent camouflage against a tree trunk. This so-called 'cryptic' plumage has its values: if the tawny owl were not well concealed, its daytime resting period would be rudely shattered by tormenting groups of mobbing birds, trying to drive it away.

Food supply Although the tawny owl is primarily a rodent killer (voles, mice and rats are all acceptable), shrews and small birds have good reason to be concerned by its presence. as their remains regularly feature in pellets. Owls often swallow their prey whole and the regurgitated pellets are made up of the indigestible remains of its prey such as bones. fur and feathers. These left-overs can provide valuable clues to its diet. In the case of the tawny owl, rodents and birds occur prominently, but the wide variety of its diet (and thus the adaptability of the species) can be gauged by the regular presence of fish. amphibian and reptile remains. Nocturnal observations show that invertebrates, particularly worms which do not leave easily



13



recognisable remains in the pellets, also feature largely when more substantial prey is in short supply.

Family planning In some uncanny way tawny owls seem able to assess the likely food supply at the start of the breeding season. In years when small mammals are low in number, clutches of eggs tend to be small; the number of eggs increases when mice, moles and small rabbits are more plentiful. Tawny owls usually have a single brood of young each year—and this occurs from mid-March onwards.

Unlike small birds, which wait until their clutch of eggs is complete, the female tawny owl starts incubating as soon as she has laid her first egg, which is like a ping-pong ball in size, shape and colour. The chicks hatch at about two-day intervals, each egg taking 28-30 days to hatch. The chick waits fretfully in the nest for food usually mice, shrews and sometimes even small birds. The first born tends to get more than its fair share of the food, the result being a considerable difference in size between youngest and oldest. If food is plentiful, then all is well. Should food fail, then the biggest chick eats the smallest one. It may sound unduly brutal, but for the survival of the species it is better that two chicks die to provide food for a third, than for all three to die of starvation. In exceptionally hard years when the shortage of food is acute, the tawny owl may not breed at all.

Above: Wedged into the tree hollow so they can't fall out, these chicks rely on their parents for food. The larger one is about two days older than the other.

The owlets fledge (leave the nest) after five weeks, but for the next three months they continue to demand parental attention with hungry 'ku-wek' calls at their regular feeding stations, scattered through the woodland, After August, the parent owls begin to reestablish their territorial boundaries and the familiar calls, 'hoo-hoo-hoo' and 'tu-whit', are often heard. The youngsters finally move off or are driven away by the parent owls. This territorial activity increases in January and is probably at its height in February and March. Autumn and winter are the times when mortality is at its highest, particularly for the young birds, when cold weather and food shortages take their toll. Sadly, some also die in collisions with cars after dark on country roads, when the owls are dazzled by headlights.

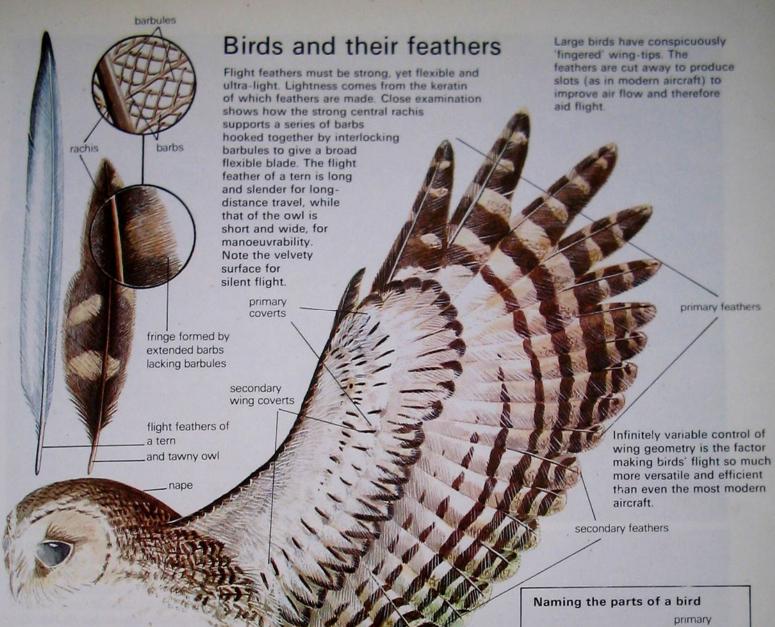
Favourite nest sites are hollow trees, or cavities found in deserted buildings. One giveaway sign of an owl's nest-or roosting siteis pellets around the base of the tree. Occasionally, eggs are laid in old nests of other birds such as magpies and carrion and hooded crows. If there is a scarcity of trees, tawny owls will even nest on the ground, perhaps choosing an old rabbit hole. Tawnies also take readily to nestboxes, and a barrel with good drainage holes, if slung at an angle beneath a high branch sheltered from direct wind and rain, will often tempt a pair of owls. The best time to go out and see tawny owls is on a clear night and at dawn, when they are returning to roost for the day.

The tawny is Britain's most numerous and widespread owl, though absent from Ireland; it's place there is filled by a different species, the long-eared owl (Asio otus). We think of it very much as a woodland bird, and to a degree this is true. However, there are plenty of mice, rats and house sparrows in towns, plenty of parks and large gardens with trees large and old enough to have holes for nesting—and of course there are plenty of suitable buildings like churches in which to nest. Add to this the very catholic diet of tawny owls, and it becomes less surprising that these adaptable birds have taken to urban and suburban life so well.

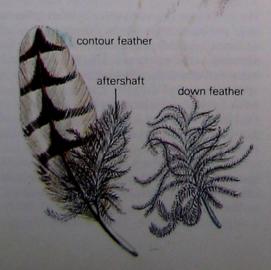
Owl pellets

Pellets are found under a roost or nest site, usually at the base of a large tree. They contain the indigestible parts of a meal—mostly fur and bones—which have been compacted in the gizzard before being coughed up. The average length is 42mm (1¾in). The average width is 19mm (¾in).

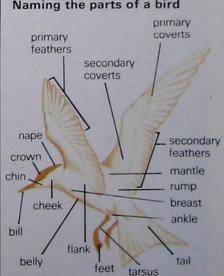




The streamlined outline of the owl is formed by stiff, specially shaped contour feathers. Between this surface layer and the body is a layer of down feathers—the bird's 'thermal underwear'—very necessary for survival through cold winter nights. This insulation may be provided by an aftershaft attached to the contour feather or by special down feathers.



Feathers are vital to a bird's survival. They power flight and supply warmth, and the colours and patterns used in courtship, aggression or camouflage are all in the feathers. Thus their maintenance is of utmost importance. Disarranged barbs must quickly be put straight to maintain flight efficiency, and this is the purpose of preening, which seems to occupy so much of a bird's time. Preen oil is applied by wiping the beak across a gland above the tail and then passing each feather through the beak, when rapid nibblings re-adjust any displaced barbules.



Whether you want to describe a bulky bird like an owl or a slim tern, the same words apply to both. The parts vary in colour and shape, providing a means of identifying each species. To help identify an unfamiliar species, it is worth keeping a note book and making a rough sketch, labelling the colour of each part.



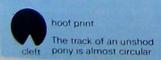
Above: Most of the year Exmoors run free in herds in October they are rounded up. driven down to the farms, inspected and branded.

EXMOOR PONY

Distribution the high open moors of Exmoor and part of Cumbria
Size of adult male 12\frac{3}{4}
hands (130cm) at withers (top of the shoulders), 350-400kg (55-63st)
Size of adult female
12\frac{1}{2} hands (127cm) at withers; 350-400kg (55-63st)
Colour brown coat black

mane and tail, oatmealcoloured muzzle Breeding season foals born April or May Gestation period 50 weeks Number of young one: twins unknown

Life-span 25 30 years Food grass and other moor land plants Predators none.



EXMOOR PONIES the survivors

Of the nine native types of pony in Britain the Exmoor is one of the toughest. Exposed to the worst winter weather, this breed copes as well as the wild red deer on this West Country moorland.

Because its ancestors evolved in an ice age (more than a million years ago), the Exmoor pony survives the cold and wet because of its behaviour and physical structure. Its coat can vary in colour between dark brown and bay and it has a surface of long, oily guardhairs that mat together when they get wet and make little triangles, so that the rain drips easily away from the tips. Below the guard-hairs, the thick undercoat stays dry and is such good insulation that in a snow storm the pony's back can be covered in snow without its body heat melting the snow.

In a winter storm Exmoors stand, like all

ponies, head down with tail towards the wind. The sensitive parts of the head are sheltered by the body, while the neck is protected by a thick, waterproof mane and the thick tail protects the rear.

Pure-bred ponies are so hardy that they can survive a bad winter as well as the wild red deer of Exmoor. The ponies are never brought in for shelter and can find all their own food—unlike cross-bred ponies which cannot survive the whole year on the moorland.

Wild or domestic? Free-living Exmoor ponies are almost wild animals—'almost' because, unlike real wild creatures, each pony belongs to someone and is branded on its flank. The branding is done in the October following the pony's birth. Every October all the ponies are rounded up to bordering farms with enclosed fields where the youngsters are examined and surplus animals sold, often for training as riding ponies. The breeding herds are soon returned to the high moor where they spend the rest of the year. Exmoor ponies are wild, however, in the sense that they have to find their own food, care for their young and are free to wander over huge areas of the moor.

The Exmoor Pony Society records show that only about 100 ponies still live the wild life on Exmoor itself. Each herd consists of as few as four or as many as 20 mares led by a single adult stallion. There will also be foals





and young ponies of both sexes in the herd.

On Exmoor itself you have a good chance of seeing free-ranging herds if you leave the road on Withypool Common or on Winsford Hill and walk a mile or so on to the moor. There is also a small herd of Exmoors which has been introduced by man into the Cumbrian hills. The other Exmoor ponies you can see in many parts of Britain are domesticated and kept as riding ponies. They are especially good for pony-trekking and, in days gone by, were used for shepherding and to pull pony traps and were crossed with Shetlands for use as pit-ponies.

All types of pony and horse can interbreed and for hundreds of years man has always crossed breeds from different areas to create special types and sizes of horse. Because Exmoor ponies are small they have often been cross-bred with larger animals in the hope of combining the hardy character of the Exmoor with the larger size of the horse. These cross-breeds make good riding ponies but they are never as tough or have quite the same appear-

ance as real Exmoors. The pure Exmoor is one of the least variable of horses—it always

has the same colouring.

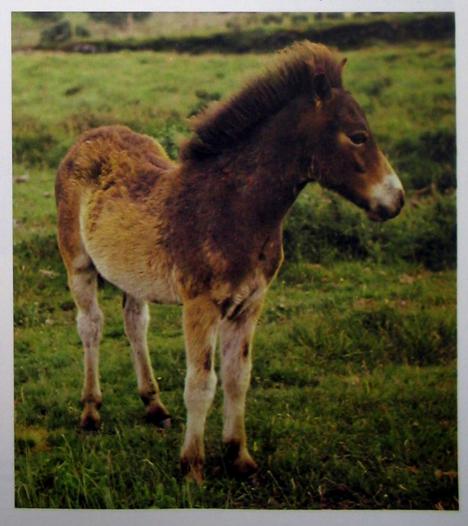
Life in herds A scientific study of Exmoor pony herds was made by Dr. Susan Gates, who spent three years watching them. The herds she studied each stayed within an area of about 800 acres even though they were free to move over much larger areas. Neighbouring herds often ranged across overlapping areas and sometimes met. Occasionally, females would change herds; but usually the herds kept apart and the members of the herd stayed loyal to their group. When the stallion of one herd was removed for a few days the mares all stayed together and avoided other herds in the area.

In April and May the herds keep well apart from each other. This is when the foals are born and start to suckle milk from their mothers. Only nine days after giving birth, the mares are ready to mate again with the stallion. The early season of birth means the foals have the whole summer to grow and get fit for the crucial survival test—their first winter.

Exmoor's evolution Fossil bones of ponies have been found dating back 100,000 years to the tundra-like conditions (i.e. frozen wastelands) of the Ice Age. The bones and long faces of the fossil ponies are remarkably similar to those of a modern Exmoor pony. These ponies may well have been domesticated by the pre-Celtic people who moved up into Britain as the ice flow receded northwards. On Exmoor the original wild ponies survived much longer and became the halfwild/half-domestic creatures they are today. This means that Exmoor ponies may well have lived in Britain long before many of the truly wild mammals of today's countryside, and indeed before man.

Above: Foals are often bought to be tamed for pony trapping at country shows and for riding. A sturdy Exmoor can carry 75kg (12st) all day.

Below: This four-month-old foal is already growing its darker winter coat. Unlike the adult it has a short, bristly mane.



THE HEDGEROW— A WINTER REFUGE

Although the land looks bleak and empty in winter, there is constant activity in the thorny hedgerow thickets. Stoats and foxes use the sheltered passageways to stalk prey; ladybirds and earwigs crawl into hollow stems for warmth and protection; and birds fly from as far as Scandinavia to feed on the berries.

The hedgerow is a particularly rich habitat because it has characteristics belonging to two other habitats—woodland and open field—attracting animals and plants from each, as well as containing its own particular species. It offers a haven to all sorts of wildlife, especially in winter when the surrounding landscape is bare and exposed.

Hedge structure At the heart of an old hedgerow lies a dense shrub layer, often a mixture of hawthorn, blackthorn, elder and dogwood. At intervals along this strip, trees such as elms, oaks and ash create a broken canopy (before the days of Dutch Elm disease about half of England's hardwood timber grew in hedgerows). These trees act as host to all kinds of woodland creatures.

At ground level, a herbaceous border hugs the hedgebank along the edge of fields. This is made up of a mixture of well-known countryside plants such as nettles, jack-by-the-hedge and lords-and-ladies. These three layers—tree, shrub and field edge—are not distinct, however, for swags of honeysuckle, wild hops, clematis, bryony, bramble and dog rose climb riotously between them, knotting the whole together.

Winter shelter Hedgerows, especially of hawthorn with its tangle of spiny twigs, were planted primarily to contain livestock, and incidentally to offer them some shelter from bad weather. In this second role, wildlife also benefits, particularly in winter. Many birds roost in hedges overnight and a small hawthorn thicket may accommodate several hundred starlings and lesser numbers of fieldfares, wood pigeons, stock doves and magpies. A dense hedge offers them protection from ground predators and also from wind which causes greatest loss of heat (and energy) during long winter nights. With the onset of winter, many insects also seek nooks and crannies in the interior of the hedge to hibernate.

Hedgerow highways Hedges act as convenient corridors, making it easy for both plants and animals to spread in safety from one habitat to another. This can be essential for the survival of a species. If, for example, a particular insect is confined to one isolated

woodland, and that wood is destroyed by fire, the species would become extinct. If the wood is linked by a hedgerow to another copse then the insect may have already colonised the hedge so the species has a chance of survival.

As hedges often radiate out from woodland edges, they also create a strip-like continuation of the woodland food supply. Squirrels, for example, shunning the exposed fields, make sorties along hedges to forage for hazel nuts. Badgers will come out of a wood to root along hedgebanks for whatever they can find.

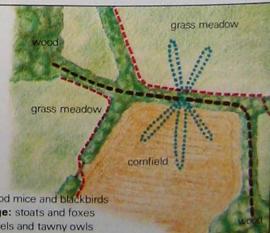
Plants which cannot spread across open fields often 'travel' along the base of a well-grown hedgerow. Shade-loving woodland plants such as bluebells and primroses take advantage of the damp and overhanging conditions similar to that of the wood. The seeds of fruit-bearing plants are dispersed along the hedgebank by birds and small mammals, often far away from the parent plant. Most berries are eaten for their fleshy outer coat. The hard seed passes through the animal undamaged, so a solitary blackberry bush can be the source of several other clumps of bushes along a hedge over a period of time.

Larder for animals The special plant community that makes up a mature hedgerow offers a wider range of foodstuffs than most deciduous woodlands, making the hedge a very attractive habitat in winter, particularly for birds. Migratory fieldfares and redwings



Hedgerow highways

Animals that live in and close to hedges use them as highways where they can travel in relative safety. Residents such as stoats and foxes use them as cover for stalking; rabbits and wood mice make short trips into fields to feed; woodland animals can move from one copse to another via the hedges.



residents: rabbits, wood mice and blackbirds
hunters in lee of hedge: stoats and foxes
wood dwellers: squirrels and tawny owls



join blackbirds, thrushes and starlings from home and abroad, and flocks of finches, buntings, sparrows and tits to exploit the seasonal succession of berries and seeds. After glutting on the autumn harvest of elder and blackberries, birds turn to rose-hips and haws, then sloes, and finally to ivy berries. Hips and sloes are taken mostly by thrushes, while agile tits collect the fruits of spindle, honeysuckle and bryony.

In winter, voles, mice and squirrels bury caches of seeds and nuts. Wood mice and bank voles are good climbers and so can get at the berries high up in the hedge. A typical winter menu would include rose-hips, haws, hazel nuts and acorns. With practice, we can

learn from seed remains who has been eating them. Wild mice eat only the hard centre of haws, discarding the fleshy coat, while bank voles do just the opposite.

Change of diet This bounty of vegetarian foods allows quite a number of mammals to remain active throughout the winter. But the predators such as weasels and stoats have to be versatile to survive. In winters when the hedgerow fruit crop is poor (hawthorn is very variable), and the rodent populations correspondingly low, predators alter their diet to include roosting birds or even move into nearby woodlands and fields in search of other food.

A few invertebrates also manage to stay

Above: Planted originally to mark boundaries and enclose patches of land, Britain's 600,000 miles of hedgerow provide a vital habitat for wildlife.

How to date a hedgerow

You can estimate the age of a hedge by counting the number of shrub species in a 30m (100ft) stretch. On average it takes 100 years for a new species to become established, so a hedge with four shrub species is likely to be roughly 400 years old.



Above: Like the more common wood mice, the yellow-necked mice are expert climbers, often using old birds' nests high up in hedges as feeding platforms where they have stored nuts and berries.

Right: The brimstone is the only hibernating butterfly you are likely to find in hedge tops. The brightly coloured male is the first to leave the clumps of ivy or holly which have protected it through the winter.





Left: The eating habits of the rabbit have strongly influenced the composition of hedges: hawthorn, elder and nettles, which rabbits find unpalatable, thrive whereas spindle bushes, which they devour, are rare.

Below: Hedges are an important port of call for fieldfares and other migratory birds which arrive from the Arctic, usually in October, to feed on the berries.



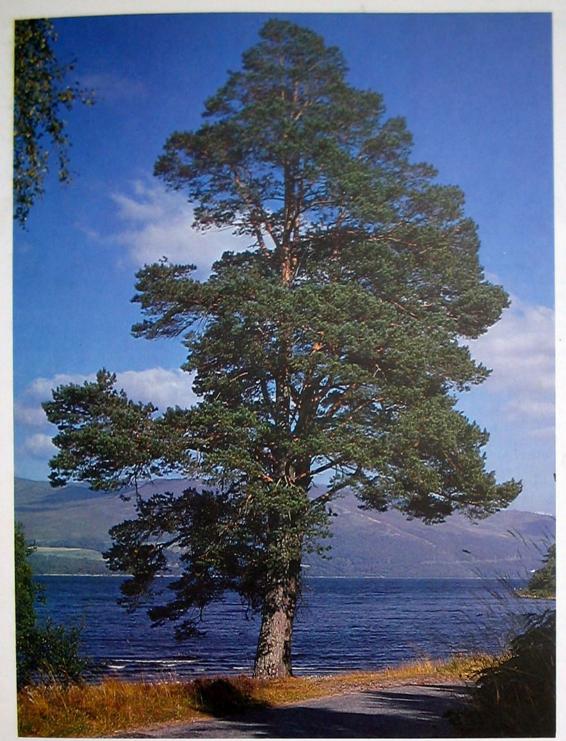
active throughout the winter, notably slugs, which tunnel deep into the hedgebank soil if freezing weather sets in. Snails are less adventurous, sealing off the entrance to their shell with a mucus plug and staying put for the duration of the winter, often in company with others. Hawthorn is a particularly good place for finding active invertebrates in winter because it favours growth of lichens and the slimy alga called Pleurococcus, both of which provide food for springtails, barklice and woodlice. A select band of mothswinter moths, spring ushers, pale brindled beauties and mottled umbers—are also active in winter, laying their eggs at this time. The most striking feature of the group is that the females are small, wingless, bug-like creatures, scarcely recognisable as moths at all. The ones we see flying around the hedgerow are the amorous males, seeking females on the trunks of trees.

Dormant insects The vast majority of insects overwinter as eggs, larvae, pupae or hibernating adults. A careful examination of any part of the hedge will yield insects: ladybirds dormant in thick beds of lichen and crevices in and under bark; earwigs huddled together in the hollow, dead stems of hogweed; the larvae of holly leaf-miner flies inside the blisters on holly leaves.

All of these dormant insects are, of course, vulnerable and supplement the vegetarian diet of roving mammals. Shrews take their toll of buried pupae; wrens, custom-built for the labyrinthine hedge habitat, mop up spiders' eggs; tits puncture the blisters on holly leaves—just as they peck through milk bottle tops—to extract the larvae of the leafminer fly.

Wind-breaks As well as providing shelter for over-wintering creatures, the hedge can also act as a wind-break for nearby ploughed fields. Where hedges have been removed on a large scale, as in East Anglia, the wind can blow in any direction over wide areas. In dry winter weather this poses a serious problem for the farmer because the fields get very dry. The crops have not yet grown much so their roots do not bind the soil, nor do their leaves protect it. The wind whips up the surface layers, together with seeds and costly fertillizer, which then disappear over the horizon in a cloud of dust. A long line of hedges greatly reduces the destructive effects of the wind.

Given its sheltered conditions and the fact that it is a great reservoir of wildlife, the hedgerow is one of the best places to look for early signs of spring. From January onwards, the territorial song of the great tit is increasingly heard, soon accompanied by the more lyrical mistle thrush. In February, elder leaves begin to unfold and a sunny day may coax out an early brimstone butterfly. Blackbirds have been known to start nesting in February and some rabbits may be giving birth to their first new generation of the year.



Scots pine beside Loch Rannoch in Perthshire. In Germany and France it is known as the red pine because of its glowing reddish bark and pinkish buds.

Female Scots pine cones One to five tiny female cones form at the tips of delicate new shoots. At this time the cones are pale pink, slowly deepening in colour to dark red as the year advances. By the second year the cones have grown considerably and have turned green. As the cones have grown, the twigs which support them have become tougher and woodier. In their third year the cones turn brown and can now open and release their seeds in dry weather.

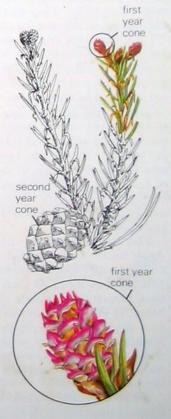
OUR NOBLE NATIVE PINE TREES

The reddish bark and windswept outline make the Scots pine immediately recognisable.

Our only native pine can be found from the Scottish Highlands to Surrey.

In the Scottish Highlands the Scots pine is a native tree; elsewhere in the British Isles it has been planted extensively only in the last two centuries. In the 18th century it was a favourite tree of English landowners who wanted something new, attractive and hardy for their parks and gardens. It provided sweet-smelling shady walks on hot summer days and shelter for wild animals, particularly deer.

Sometimes you may see a clump of seven trees growing together on the top of a hill; they were thought to bring good luck, and the trees' imposing silhouette against the sky made them an attractive focal point. Indeed, wherever in the world the Scots pine grows, it is thought of in folklore as a symbol of fer-



Looking inside a pine cone



tility, longevity (it may live for a couple of centuries or more), and good fortune—perhaps because it is a tree that stands firm amid the relentless snows of mountain winters and still keeps its leaves miraculously green.

Except when very young, Scots pines are easily recognisable by the redness of their smooth, shining branches and upper trunk, the colourful bark peeling off in thin flakes. In mature trees the lower part of the trunk is also reddish, but much darker and rougher, and the thicker bark is quite heavily cracked. In natural woodlands the pines are well spaced with wide-spreading boughs and shapely rounded crowns. In old age they lose this conical outline as their lower branches fall off and they become flat-topped and sometimes rather stricken-looking.

Needles, flowers and cones The needles, blue-green and slightly twisted, are mostly about 5cm (2in) long, shorter than those of most other pines. They stand stiffly in pairs and remain on the tree for two or three years.

Like all pines, the Scots pine is wind-pollinated. It flowers in May: the female flowers are solitary, small pinkish red globes which develop at the tip of the shoot. If they are fertilised by some of the millions of male yellow pollen grains, they produce green to light brown cones; these take two years to become fully grown and may reach 7cm (3in) in length. There are two winged seeds attached to the inside of each woody scale of the cone. When the cones open in warm sunlight the seeds are scattered by the breeze and many are avidly eaten by all kinds of birds and mammals.

Pine forests Until the end of the Middle Ages much of the Scottish Highlands were covered with forests of Scots pines. From the 17th century onwards man began to attack these forests: for example, the forest of Loch Maree in Western Ross was cut down in 1612 and the timber used in iron-smelting. Deforestation continued with ever-increasing enthusiasm and sadly today the native pine woods of Scotland survive only as pathetic remnants.

Scots pine trees grow mostly on welldrained slopes covered by gravel and coarse sand left by glaciers. The soil is not fertile enough to be farmed but the pines, along with some birches and junipers, find it acceptable. To see Scots pines at their best you should go to places such as Glen Affric in Inverness-shire, the Ballochbuie district of Aberdeenshire or Rothiemurchus on the north-eastern slopes of the Cairngorms.

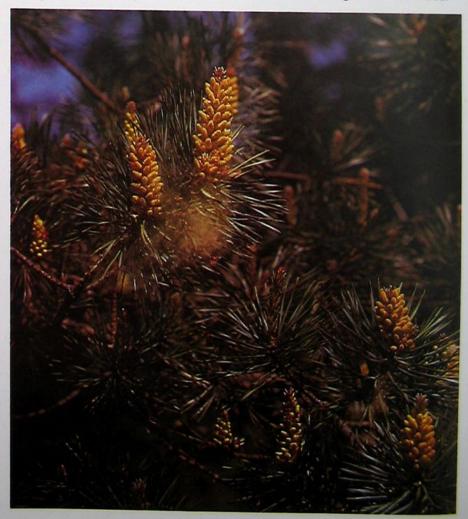
These Scottish pine forests, where pines of all ages and sizes grow amid majestic scenery of mountains and lochs, support a rich variety of wildlife. The best known mammals are the deer: roe deer live among the trees all year, red deer seek forest shelter mainly in winter. A rare carnivore of the weasel family, the pine marten, is aptly named, for the old forests are among its haunts. The forests are one of the last refuges of wild cats and red squirrels. Rare orchids and wintergreens, and birds such as crested tits, capercaillies, crossbills and even occasionally osprey also thrive there.

Pine cultivation Because it thrives in poor, rather dry soils, Scots pine is still a favourite tree to plant in sandy areas of south and east England where the ground is unsuitable for agriculture; hence the various long-established plantations in Surrey and elsewhere, such as those near Hindhead, Leith Hill and between Weybridge and the Chobham ridges. The Forestry Commission has planted this pine in places like Thetford Chase in East Anglia and Cannock Chase in Staffordshire. When the trees are regimented in plantations



Above: Scots pine (*Pinus sylvestris*), evergreen, native in Scottish Highlands, planted elsewhere. Grows to 40m (130ft). Lives up to 200 years or more. Found on poor, well-drained peat and sandy soils.

Below: So much pollen is produced by the male catkin that, over a large forest, it can hang in a dense cloud.



they have little beauty; being so close together, they shade each other's branches and become more rows of tall poles with all their foliage at the tops of the trunks.

Pine timber is in great demand these days and as we do not produce enough ourselves we import large amounts from Scandinavia and elsewhere. Carpenters know it as red or yellow deal (white deal comes from spruces). Scots pine timber is used for telegraph poles, scaffolding, railway sleepers, gates, buildings, furniture, paper pulp and for many other purposes. In the two world wars vast numbers of highland trees were felled, many of them to make ammunition boxes. By-products of pine forests include tar, pitch, resin and turpentine.



European larch-young cone pink, later

The mature bark of the lower trunk of the Scots pine tree cracks as the tree grows and expands its girth. New bark is being formed underneath.

Pine cones usually conical; thick woody scales each with 4-sided blunt tip. Shown: Scots pine—hanging cone initially red, becoming green and brown in third year. Blue-green needles in bundles of two.



Fir cones usually conical with papery scales. Shown: Douglas fir—hanging brown cone has protruding scales. Short, single flat needle-like leaves.

What's that cone?

The pine family, (Pinaceae), includes pines, cedars, firs, spruces and larches. Most of these trees have evergreen needle-shaped leaves that remain on the tree for 2-3 years, though the European larch is deciduous, shedding its needles each autumn. The young female cone looks like a bud—red, blue, white or green, according to the species—when it appears in spring. After fertilisation by the male catkins (which appear on the same tree) it becomes brown, woody and full of seeds.



Cedar cones roundish with tightly overlapping scales and flattened top. Shown: Cedar of Lebanon—purplish green erect cone. Tufty spiky needles grow in clusters from short shoots.





Insects you can find on pine trees Many insects can be found feeding on or inside a pine

feeding on or inside a pine tree.



Hyloicus pinastri

This large moth—8.5cm (3½in)—rests by day on the trunk. The caterpillar feeds on pine needles. Rare, but increasing in woods in the south.

pine flatbug Aradus cinnamomeus 5mm (¼in)



This bug lives just under the bark. It sucks sap from the wood.



pine weevil Hylobius albietis 12mm (½in)

pine beetle Myelophilus piniperda 5mm (¼in)



Both beetles are serious pests. They feed on young shoots and so stunt the growth of the tree. The pine beetle larva lives in pine logs; the weevil larva lives in rotten stumps.



HIBERNATING TO SURVIVE WINTER

Our hibernating mammals—hedgehogs, dormice and bats—literally 'switch off' in winter when food becomes scarce. So ingenious is the technique that scientists have been considering how to induce hibernation in deep-space astronauts.



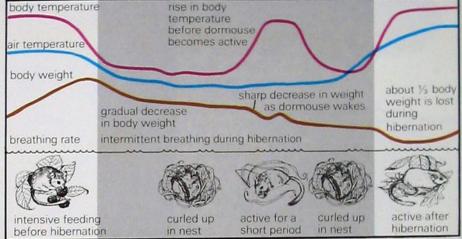
Some animals solve the problem of living through the winter months, when food is scarce or unavailable, by hibernating. Only a few British species in fact hibernate; they are hedgehogs, dormice and bats. Many cold-blooded creatures such as frogs, snakes and snails become torpid in winter, but it is only the warm-blooded animals that change from their warm state, with a constant body temperature, to a cold state, in which their body temperature fluctuates with the surrounding air.

Switching off Hibernation is usually compared to a deep sleep; but it is more than that. The body's processes re-adjust completely: the heart beat slows, breathing almost stops and the body temperature falls to within a few degrees of freezing. These changes ensure that the body uses minimal amounts of energy to maintain life. For example, a fall of 20°C (35°F) in body temperature reduces by three quarters the rate of chemical reactions in the body and the consumption of stored food reserves. In hibernation the body barely 'ticks over' in a state of suspended animation. The animal is stiff and cold, almost dead.

There has been considerable scientific interest in the mechanisms of hibernation because, if they could be applied to humans, astronauts could make long-duration flights without needing to carry several years' supply of food. During hibernation, physical damage is less traumatic to an animal's body, so there is also medical interest in hibernation as a way of improving the human body's tolerance to major surgical operations.

Hibernating animals are thus virtually 'switched off' for the winter, with the great advantage that they do not need to feed at the very time that food is unavailable. The price they pay is that they are totally immobile and therefore vulnerable to climate and predators. So it is essential for them to choose a protected place in which to hibernate.

Choosing sites Dormice and hedgehogs try to gain protection by building a special nest called a hibernaculum. The common dormouse chooses the bottom of a hedge or the base of a coppiced hazel. Hedgehogs may use old rabbit burrows, but usually construct a



nest under brushwood or brambles, or tucked up against a log. The hibernaculum of the hedgehog is a sturdy construction made of tightly packed leaves. These form an insulating layer which maintains the inside of the nest at between 0° and 5°C (32°-41°F) for most of the time. This is the best temperature range for hedgehogs to hibernate efficiently. The nest also keeps the occupant dry and protects it from snow and frost.

The hedgehog is totally dependent upon its nest for the three or four months passed in hibernation. These hibernacula are so snug that other animals—such as bees and mice—often move in when the hedgehog has left. Sound construction means nests may last for up to 18 months; but hedgehogs do not usually reoccupy old nests. In fact they may build several in the space of a few weeks—almost as though they were practising the art—and then use only one of them. These spare nests may be useful if the chosen hibernaculum is destroyed or flooded out during the winter.

Where bats hide Most of the 16 species of British bats are solitary hibernators, although a few spend the winter in small groups. Bats often select a humid cave, cellar or hollow tree in which to hibernate—two species always hibernate in caves and six prefer to use these dark, undisturbed dwellings if possible—because they offer a relatively constant temperature and a high humidity. These conditions are particularly favourable because

Top: This tiny hibernating dormouse is oblivious of the fact that it has been taken from its winter retreat of dead bracken (opposite page). Hibernating mammals should not be disturbed from their deep sleep, since arousal forces them to use up precious reserves of fat unnecessarily.

Above: This chart illustrates how our hibernators solve the problem of losing energy because of winter food shortages. They switch off their central heating and allow body temperature and heart and breathing rates to fall. Their cold, torpid bodies just tick over, relying on the energy stored in the reserves of fat.

Making a hibernaculum

In autumn the hedgehog carries the fallen leaves of deciduous trees to a sheltered place under some brambles. When a large pile has been gathered, the hedgehog crawls inside and moves round and round until the loose leaves have become tightly packed against the bramble branches. This secure, weatherproof nest will be its home—hibernaculum—during the cold winter.



they prevent the bats losing water by evaporation. (Some bats, however, will select areas as near to freezing point as possible to conserve energy.) Constant conditions are also helpful because bats do not then need to cope with unusual warmth or cold, or climate changes. Old mines and large roof spaces such as in barns and attics are therefore also good locations for bats.

Bats hang upside down (some believe this is to reduce the stress on their hind legs) and where they roost varies according to the individual species. The horseshoe bat hangs from the roof of a cave, while the Daubenton's bat squeezes itself into crevices in cave walls or may burrow among loose material on the cave floor. Other species of bat hibernate in trees or buildings, but if the weather gets very cold they will move into caves. Perhaps for bats hibernation can be seen as a strategic alternative to migration.

Interruptions Hibernators are at risk if the air temperature falls too low. Below 0°C (32°F) there is a risk of ice crystals forming in the animal's blood; this would be fatal. Hibernating mammals usually allow their body temperature to fall and match that of their surroundings, fluctuating as the air temperature goes up or down. But if the environment cools below 1°C (33°F), the animal's body functions 'switch on' again and either keep the body ticking over at just above freezing or arouse the animal to activity.



Most people think of hibernation as an unbroken event, deep sleep from November till March. In fact arousal is frequent during that period. This is why bats may be seen flying in mid-winter and hedgehogs are killed on roads in January and February. Experiments show that hedgehogs wake up every couple of weeks or so and it is rare for a hedgehog to stay in the same nest for the whole winter. Bats stir naturally too, while with dormice the periods of unbroken slumber are probably quite a lot longer. Animals will also stir if disturbed.

Living off fat Hibernators have large stores of white fat (similar to the fat on joints of meat). This substance forms the body's 'fuel', to keep it ticking over. Some hibernators, such as pet golden hamsters, store food in the form of caches of nuts and seeds; but hedgehogs and bats cannot do this and so they must store a whole winter's energy requirements, in the form of white fat, in their bodies. Masses of it accumulate under the skin and around the body during the early autumn. By the time hibernation begins, fat may account for over a third of the animal's total weight. All this food reserve may be used up in the course of four months' hibernation.

Clearly it is essential that enough fat is stored away before hibernation starts. In some years, bad weather in late summer or early autumn makes this very difficult to do because insects and other food are in short supply. True hibernators, such as this hedgehog, do not always sleep right through the winter uninterrupted. It is quite common for hedgehogs to move to another nest if they wake up before spring.

The hedgehog's nesting material

The hedgehog prefers to use the leaves of broadleaved trees to make its protective nest (hibernaculum). These trees are found as far north as latitude 60, which corresponds to the approximate northern limit of the hedgehog's range. It may well be that the survival of the hedgehog depends on the availability of suitable leaves with which to make a winter nest. More support for this idea comes from the fact that hedgehogs are rarely found in coniferous forests, where suitable leaves for nesting material are scarce.

Waking up is not a simple matter. The main problem is to raise the body temperature through 30 degrees or more to the normal active level. This is done by using a special tissue called brown fat, which forms orange-brown lobes in the body, especially in the shoulder region (often called hibernating glands). The sole purpose of this fat is to generate heat when required. Warmth is circulated round the body by the blood stream; when the muscles are warm enough, they begin to shiver and produce more heat. It may take half an hour for a small bat to rouse itself fully; larger hedgehogs could take over twice as long.

Every time a hibernator wakes up, it consumes quantities of brown fat. So it is important not to disturb hibernators unnecessarily because this will reduce their chances of getting through the winter on their remaining fat reserves. Bats are particularly sensitive to disturbance in winter and their chances of survival are diminished if they are aroused, especially by intruding cavers stumbling unwittingly into their retreat.

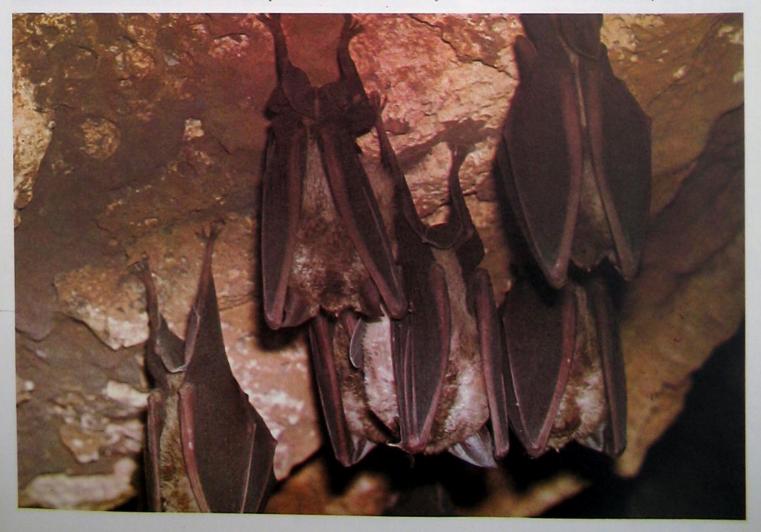
Knowing the time It is not known exactly what causes an animal to begin hibernation or end it. It is likely that hibernation ceases when the average air temperature rises above a certain level in spring. Should a period of cold weather then return, the animal will resume hibernation until conditions improve. The stimulus for a bat in the shelter of a deep

cave, where the temperature hardly changes, must be much more subtle than that for the comparatively exposed dormouse in its leafy nest.

Temperature is also crucial at the onset of hibernation, but in this case it is only one of a complex of factors which warn the animal to begin hibernating. For example, if captive hedgehogs are kept well fed, they will refrain from hibernating even in quite cold conditions. If their food is stopped, however, they will hibernate while it is still comparatively warm. In fact hibernation is probably triggered off by a combination of weather conditions and food shortage, which normally occur together in autumn.

Without their ability to hibernate, it is doubtful if bats and hedgehogs (and probably dormice too) could find sufficient food during our winters to survive. Although often successful, this strategy is not, however, without risks of its own. The major re-adjustments that the animal undergoes are a severe challenge to the body's machinery. The reliance on stored fat reserves is also something of a gamble. Will there be enough to last? What if spring comes later than usual? Hibernating animals cannot defend themselves against predators, either. So it is scarcely surprising that many die each winter, especially animals hibernating for the first time. Between 30 and 60 per cent of hedgehogs and bats never live to see their first birthday.

Greater horseshoe bats—one of the largest and rarest species in Britain—hang in a cluster upside down in a humid cave; this hibernaculum helps minimise loss of water and, most important, stays at a constant temperature.



THE DAISY FAMILY

The defiant daisy springs up to frustrate gardeners almost as soon as it has been mown down and appears even in the middle of winter. It gives its name to one of the most prolific and colourful floral families.

There are at least 100 native and hundreds more introduced species in the daisy family—or Compositae—making it one of the largest families in our flora. It is also one of the most conspicuous families and includes the familiar daisies, ragworts, groundsels, thistles, dandelions, coltsfoot and a host of other similar plants.

The common daisy is probably the best known composite. Anyone who has played 'she loves me, she loves me not', pulling the petals off a daisy, might have noticed that its 'flower' is different from that of, say, the winter aconite or barren strawberry. Under a magnifying glass you can see that each daisy 'flower' is not one flower but many separate flowers on a dome at the top of the stem. Each head has about 150 flowers of two quite different kinds: there are about 100 disc (yellow) flowers clustered in the centre and about 50 spreading ray (white) flowers. Both kinds of flower bear seeds, but only the disc flowers produce pollen.

The whole daisy head resembles a single flower and functions like one too. It opens, attracts insects by offering pollen and nectar, becomes pollinated and withers as its seeds ripen. It is this compound head of flowers, which functions as though it were one flower, that basically characterises the daisy family.

The daisy blooms in profusion from spring to late autumn, and even in mid-winter you may see a few flowers on sunny days. Its ability to survive both winter rain and frosts and summer dryness and heat accounts for some of its success as a weed. Also the daisy has all its leaves and buds at ground level and its flower head grows on a leafless stem; so as soon as the lawn mower chops off one daisy head, there is another bud ready to shoot up and burst into flower.

Dandelions are one of our most successful and conspicuous composites. Since their feathery fruits, each containing a single seed, are widely dispersed on the wind, dandelions colonise recently cleared ground and, once established, their deep, long-lived and exceptionally tough roots help them to survive all but the most determined efforts by man to remove them. Even a small piece of root left



in the ground can regenerate a whole plant within a very few weeks, easily defying a casual gardener.

There are more than 100 types of dandelion and they grow in a variety of habitats ranging from wet marshes to dry chalky grasslands. They reproduce asexually. The seed embryos are not fertilised by insect pollination (as they are in many other types of flower). Confusingly, however, pollination is often required for the development of the seeds, and this happens when dandelions attract nectarseeking insects.

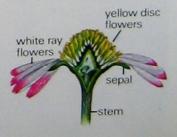
Oxford ragwort, despite its name, is not native to Britain: it probably originated from Sicily where it grows high up on the larvastrewn slopes of Mount Etna. It escaped from the Botanic Garden at Oxford towards the end of the 18th century. With the coming of the railways its plumed seeds were sucked behind trains along the cinder tracks which provided them with a similar habitat to their native volcanic slopes. Now Oxford ragwort is a common weed in many industrial areas and has even 'fathered' a new and exclusively British species, the Welsh ragwort.

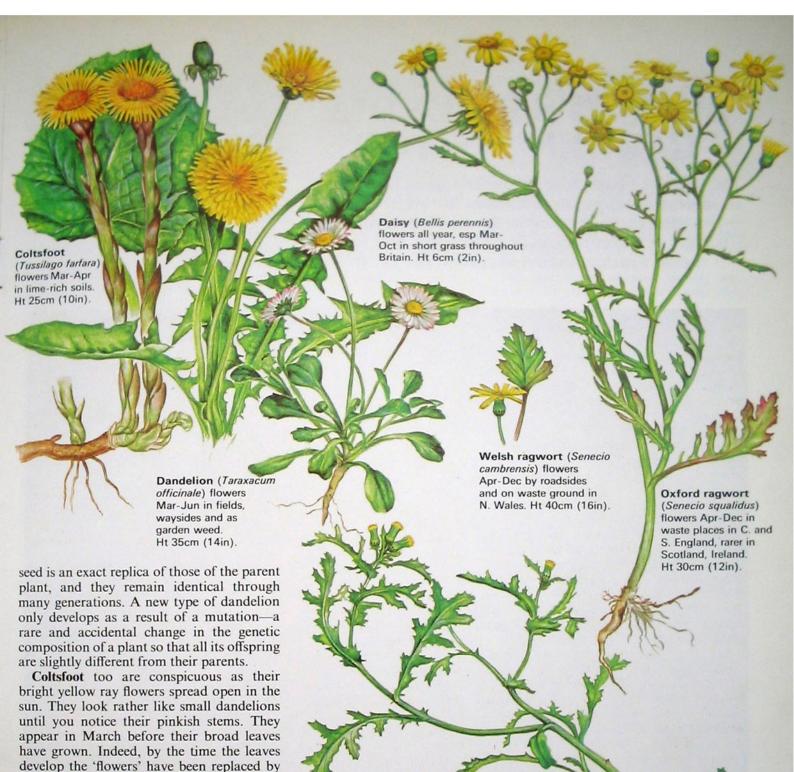
The reproductive processes are complex. The pollen is usually sterile and the whole flowering effort from March to June, when countless millions of yellow heads brighten the countryside, seems like one vast charade: an ostentatious display of colour that is by no means always necessary for its survival. Each

The daisy—a contraction of day's eye—is so-called because in full sunshine it opens wide but as the light fades the petals close. In gloomy weather all you will see is a pink-tinged 'bud'.

The composite head

The flower heads of all members of the Compositae are made up of masses of tiny flowers, hence the family name. Ray flowers, bearing long white petals or rays, form the border of the daisy and yellow disc flowers, which do not have petals, make up the central portion. Each of these inner flowers produces pollen and fruits; those around the margin only produce fruit.





feathery 'seed heads' that are dispersed by the

slightest puff of wind. The Welsh ragwort's other parent was the groundsel. These two species crossed earlier this century at the Brymbo steelworks near Wrexham, Clwyd. Hybrids between species are usually sterile and would be expected to die without leaving offspring. However, by chance this hybrid was fertile and its descendants survive, recognisably different from both of their parents and not able to cross-breed with them. They are in effect a newly formed species. Welsh ragwort is still relatively rare. It is a particularly interesting plant to botanists because it is new, native and exclusivevery few plants or animals are restricted to Britain.

Groundsel is a common weed that scarcely stops blooming in sheltered sites, even in the

middle of winter. Its flowering heads are neither obvious nor flower-like because they lack the cluster of bright yellow ray flowers you find in many composites. But they too produce thousands of seeds that are carried off by the wind. The plants make an excellent vegetable for pet birds and rabbits in winter-

Winter heliotrope is a particularly attractive member of the daisy family. Its strongly fragrant, lilac flower heads attract some of the few insects bold enough to venture out in the milder days of January and February. This plant used to be confined to gardens, but it is now quite common in hedgerows, waste places and beside streams.

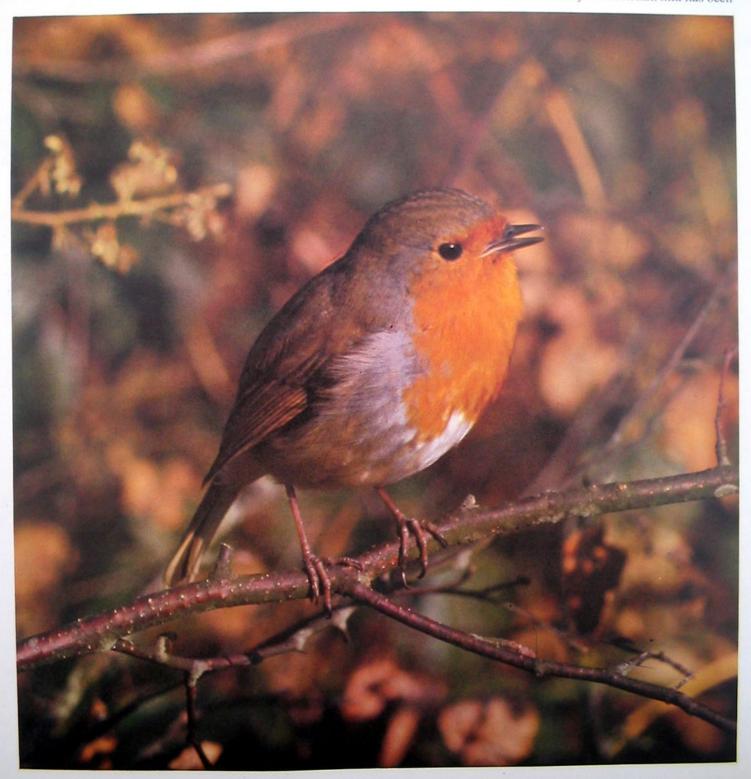
Groundsel (Senecio vulgaris) flowers all year in cultivated ground throughout Britain. Ht 40cm (16in).

BRITAIN'S FRIENDLY GARDEN VISITOR

The robin is a particular favourite among bird lovers; everyone enjoys the attentions of this familiar redbreast in the garden during winter. But despite all the efforts made to feed this bird in the harsh weather, thousands perish each year.

The robin enjoys a popularity with man unrivalled by any other species. A familiar visitor at the bird-table in winter and constant gardening companion, even nesting in the toolshed, it is a year-round bird. This close association with man is a special feature of the robin's relationship with the British. Robins of exactly the same species nest over most of Europe, but a tendency on the continent to shoot and eat small birds has made robins there generally shy and retiring woodland birds.

The bird's popularity in Britain has built up over the years and legends about the bad luck incurred by anyone harming a robin go back to the 16th century. A Christian link has been



attached to the legend because the robin's red breast was supposedly stained by blood after the bird had been pricked by Christ's crown of thorns. This is why the robin features prominently on the earliest Christmas cards.

Pairing and nesting The adults get together as pairs in early January. As they look exactly alike, the sexes can only recognise each other by display and posture. An unmated male singing loudly in his territory will, at first, behave aggressively to any intruding robin. If the intruder is a male it either retreats or tries to oust the occupier. If the new bird is a female seeking a mate, she persists in approaching the resident male, apparently unimpressed by his threats. Over a period of some hours, sometimes as much as two days, the bond between the two is built up so that they accept each other.

In many species this pair-bonding is directly followed by nest-building and egg-laying. With the robin, pairing is accomplished weeks or even months before any nesting attempt is made. During this time the birds occupy the same territory and recognise each other as mates but do not pay much attention to each other. As the weather improves the hen bird starts to build her nest, using moss and dead leaves and lining it with hair. In the natural state she may choose a rocky crevice or hollow of a tree, most often, a bank or an ivy-covered tree—usually well concealed and difficult to find.

However some robins select the most unlikely sites. One nest was found in a chest of drawers in a toolshed. The drawer was half-closed and the nest at the back was only discovered when the drawer was opened.

When she begins to build the nest the female also starts to receive food from the male. This so-called 'courtship-feeding' was initially thought to be a ritual designed to reinforce the pair-bond between male and female. In fact it is an important source of food for the female—one that she almost completely relies upon during incubation.

The clutch of white eggs with pale reddish freckling is laid, one egg each day, and the complete clutch is generally five or six eggs, although up to nine have been recorded. The Robin (Erithacus rubecula). Also called redbreast; 14cm (5in) from beak to tip of tail; 5-9cm (2-4in) high. Distribution nationwide.

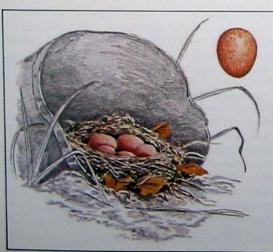
Below: Hungry fledglings wait to be fed in their nest, which is usually made up of twigs, grass and moss. Robins are well known for making their nests in such unlikely places as kettles, old buckets—even the pockets of jackets left in garden sheds.

incubating female loses the feathers from her breast and belly and the blood vessels just under the skin enlarge greatly. The bare skin and increased blood supply allow her to transfer heat more efficiently to the eggs.

Greedy chicks After two weeks the eggs hatch out and the blind chicks, covered in thin dark down, increasingly dominate the parents' lives with their enormous appetites. Both adult and young robins feed on insects, spiders and worms. They do not generally eat seeds or berries. About 15 days after hatching these young robins, now weighing more than their parents, leave the nest.

Two particularly attentive parents were reported by naturalist David Lack. They





Five or six eggs—12mm (½in) long—are laid and incubated for two weeks. Eggs generally have a whitish background and orange/brown freckles.

Nests vary in size. They are made of dead leaves, grass, moss and hairs; very few feathers are used as lining. built their nest in a cart which had to go on a 200-mile round trip just after the young hatched. Undaunted, the adult birds accompanied their offspring, feeding them on the way.

When the young birds leave the nest they face two or three days of great danger since they cannot yet fly well. At this stage they have a soft speckled brown plumage with no trace of their parents' red breast. By the beginning of June they start to lose their body feathers and to develop their red breasts—growing from the bottom upwards. The wings do not moult but continue to develop until July of the next year when they reach their full size.

Second brood Once the young are fledged the adults build a new nest within the same territory and, unless they are prevented for any reason (disturbance by a cat, flooding of the nest in bad weather or thoughtless hedgecutting), will raise another brood in May. During the summer for a period of five weeks, the adult robins replace their old feathers with new ones. They stay in the same area, but make themselves less obvious and less active, concealed in shrubberies and thickets. During this moult the adult robins also fall silent-the only time of the year when the robin song is not a feature of the British countryside.

As the second brood of young birds acquires its red plumage and the adult birds their replacement plumage, the autumn song starts up. The rich and fruity spring song of the males gives way to the thinner, more piping song of young and old, cock and hen, as each claims its own territory; this is kept, with a few local alterations, through the winter until pairing takes place. In times of real food shortage, territoriality breaks down as all the birds concentrate on feeding.

Population control Although some British robins migrate each autumn, most stay within a mile or two of their birthplace. So what happens to all these robins? If each pair of adults raises two broods with five or six young in each, there are six times as many robins at the end of the breeding season as at the start. A single pair would become almost ten million pairs at the end of ten years—about twice the total British population of robins. In fact the majority of them die. As many as a million robins may be killed by cats; while owls, cars, plate glass windows and harsh winters also take their toll. Sadly, but naturally, of the original pair and their offspring, on average only one adult and one youngster survive to breed the following year. Harsh winter weather often provides the greatest danger; so millions of people who feed birds leave out all sorts of titbits-even mince meat and grated cheese-to ensure that 'their' robins are the ones to survive. This feeding also encourages the robins to stay in backyards and gardens.



Left: A spotty juvenile robin, speckled brown and with no hint of a red breast which develops later in the summer. In its first year, the robin has a one-in-six chance of survival.

Below: Proudly displaying its red breast and singing its rich spring song, this robin lays claim to its territory and warns off other birds.





Competing for space

Almost all birds are territorial. It is generally during the breeding season that each bird defends a home area, and will not tolerate any bird of the same species apart from its mate within its territory. Robins are no exception, and like other song birds (such as blackbirds and song thrushes) they stake out quite large claims by their presence at strategic songposts. Other birds restrict themselves to much smaller areas—gannets, for instance, only defend the immediate nest area.

The blackbird singing on your television aerial may seem full of the joys of spring but, much more important to itself and other blackbirds, it is saying: 'This is part of my territory-keep off'. If the message is not understood it may still have to chase off the encroaching birds—a sight often seen when disputing birds dart at each other along a lawn or hedgerow without actually making contact. It is both these aggressive flutterings and song patterns that prevent actual fighting—unless large numbers of birds are competing for a very small territory.



THE TROUT: A FISH FOR ALL WATERS

The bewildering variety of colours, markings, sizes and habitats of the trout once led naturalists to recognise over ten separate species. Today it is regarded as a single species with two main forms: the non-migratory brown trout of rivers and lakes and the sea trout which migrates to sea and returns to spawn in the river in which it hatched.

The brown trout favours fast-flowing rivers, streams or lakes, where the water is clean and has a reasonable amount of oxygen. Access to suitable spawning sites, which are usually in shallow water with small sized pebbles forming the river bed, is also important.

In Britain the brown trout is therefore only naturally scarce in the lower reaches of large lowland rivers. Otherwise it is a hardy fish surviving even in the harshest moorland brooks where other species would perish. Its basic colour is a greenish-brown on the back, with lighter sides and a paler yellow belly. The sides also have black and red spots, some of which may be circled with white. The trout living in large lakes (sometimes called lake

trout) and rivers tend to be even lighter in coloration and larger than the brightly coloured trout living in small streams.

The sea trout has the same general body shape but its colouring is strikingly different. Its back is silvery blue and the sides and belly brilliant silver, with a sprinkling of dark spots on the upper sides. It does not have the red spots which are so typical of the brown trout. The sea trout also tends to be very much larger. As its name implies, it is found in most of our coastal waters, particularly around estuaries, and in rivers.

Migration Brown trout are thought of as non-migratory, but even these trout move down river (ie migrate) from their nursery Brown trout vary in colour from bright silver in lakes to very dark in muddy pools. This fish has adapted its colour and markings to its surroundings.



streams, and others travel further into lakes. Sea trout, as their name implies, migrate to sea. Some trout, however, never leave the stream in which they were hatched. Those that move downstream do so between one and four years after hatching, in search of more food.

The young brown trout move downstream, from the nursery area into large brooks. The fish have up to nine dark oval blotches (parr marks) on their flanks and at this stage are known as parr.

By tagging young trout it is possible to trace their movements; after migrating to lakes and larger rivers the mature trout return each year to their nursery streams to spawn. Sometimes large trout move up streams only deep enough for them to swim in for a few hours after heavy rain. Trout probably learn the chemical 'fingerprint' of their home stream soon after hatching and return to it because they know it is a place where successful spawning can take place. A few trout must, however, go astray or they would never be able to colonise new streams.

The young fish that migrate to sea are known as smolts; they are brilliant silver in colour. If you were to catch one at this stage you could rub off the silvery pigment with your fingers and the parr marks would be visible underneath. The smolts migrate in spring down rivers. They then spend several years in coastal waters before returning to



their native stream to spawn in successive years. One sea trout is known to have spawned 12 times and reached a size of 13kg (28lb).

Colour variations Essentially, all kinds of trout vary their colour to blend in with their environment by altering the proportions of pigments in their skin, a process which happens automatically as a result of the information the eyes receive about the colour of the fish's background. The colour of brown trout can vary dramatically depending on their surroundings; many trout in lakes are silvery whereas trout in peaty brooks can be almost black. With sea trout, should the young be prevented from migrating to sea, perhaps because of a man-made dam or an inflow of pollution, they remain in the river and stay indistinguishable in colour from the non-migratory brown trout.

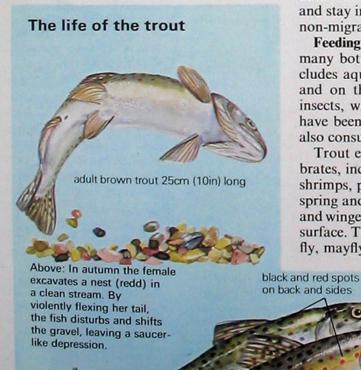
Feeding The brown trout's diet contains many bottom-living organisms, but also includes aquatic animals drifting in midwater and on the surface. Some flying and land insects, which have fallen into the water or have been washed in during heavy rain, are also consumed.

Trout eat an enormous variety of invertebrates, including freshwater shellfish such as shrimps, pea mussels and water boatmen. In spring and summer they favour surface food and winged insects which alight on the water's surface. These include many species of caddis fly, mayfly and midge and it is imitations of

female

male

Sea trout grow faster, are larger and travel further than brown trout. While at sea they face problems from larger fish and seals. On return to fresh water, they often bear scars left by unsuccessful predators.



Left: Males compete for the right to join a female by the redd, after which eggs and sperm are shed at the same time.

After spawning, the female fish moves upstream and covers the eggs to a depth of 5-10cm (2-4in) with gravel (below); in so doing she excavates another redd—a process which is continued until all the eggs have been shed. Clean, oxygen-rich water passes through the redd and over the eggs, which take 60-150 days to develop.



clouds of sperm (milt)

these that the angler uses to catch trout. Adult trout also feed on many smaller fishes, even young trout and salmon. The sea trout feed on small fish and crustaceans, and are themselves a target for larger fish such as cod and even seals.

The type of food eaten by trout makes a difference to the colour of the flesh. Brown trout which have fed heavily on crustaceans such as freshwater shrimps have orange coloured flesh, due to the presence of a carotene pigment in the shrimps. This is the reason why sea trout flesh is usually orange-red (as marine shrimps and prawns form a large part of their diet).

Trout sizes The trout's growth rate depends on the type and quantity of its food. Growth also depends on temperature. The sea trout grows fastest of all and may attain a length of 1.4m (55in) and a weight of 13.6kg (30lb). Brown trout in small brooks will probably not grow larger than 23cm (9in), and those which pass all their lives in the acid waters of larger Scottish lochs where there is little food grow very slowly, many taking six to eight years to reach 35cm (13in). However, at the other extreme, in some shallow water lochs trout turn to fish-eating at an early age, feeding on the land-locked shoals of arctic charr, a species which has been trapped in some lochs since the end of the last glacial period. These 'ferox trout' have been known to weigh as much as 10kg (22lb) and live between 15 and 20 years.

Territorial fish Trout are territorial and the largest, dominant trout will occupy the best position or 'lie'. Favoured lies in rivers will be where a good food supply is brought down by the current and where it is sheltered, for example where the river bank has been undercut or where the fish is hidden by overhanging vegetation. When an angler catches a good sized trout from a lie it is often soon reoccupied by a smaller, previously subordinate fish.

Stocking Trout live in a hard world. Those which are not caught by anglers or taken by predators, such as mink, otters, herons or cormorants, face a range of threats from pollution and other man-made problems.

large dark eyes

The over use of agricultural fertilizers and the discharge of treated sewage effluents into lakes has resulted in a form of pollution by enrichment which makes them less suitable for trout and more so for their fish predators and competitors. In rivers such pollution can blanket the trout's spawning grounds with silt.

As a result of these pressures rivers and lakes are often stocked with brown trout from hatcheries, in which the fish are artificially reared. Stocking takes place where trout would be unable to spawn naturally, for example in reservoirs, or to increase the number of trout in waters where they do occur naturally. Reservoirs are often stocked with quite small trout, whereas in rivers they will usually already be large enough for the angler to take. During the first few weeks after stocking these trout will be far easier to catch than the native fish because they are less wary and in the hatchery have become conditioned to feeding exclusively at the surface.

Rainbow trout Many still and running waters are stocked with the exotic rainbow trout (Salmo gairdneri) which was first introduced from the west coast rivers of the United States. It is easily distinguished from the brown trout by the prominent pink or mauve band along its flanks; and it is valued by anglers because it grows very quickly. The rainbow also has a seagoing form known as the steelhead.

adult male sea trout



The trout (Salmo trutta) has two main forms, chiefly distinguished by their life history, the brown trout and the sea trout.

Size of brown trout varies with habitat, from about 20cm (8in) in small streams to 80cm (31in) in big lakes; (sea trout generally larger). Weight of brown trout ranges similarly from 225g (½lb) to 2kg (4½lb); (sea trout generally heavier). Lifespan 4-6 years on average.

alevin

2cm (¾in) long

Above: Newly hatched trout (alevins) feed on their yolk sacs for 2-4 weeks. When about 2cm (1in) long, the yolk being almost used up, the young trout must leave the redd and seek food such as water fleas.

Right: Young trout (parr) have thumbprint-like marks on their sides. Parr are highly territorial and defend an area a few centimetres across.

OAK TREE GALLS

The fruit-like growths that appear on oak trees from spring onwards are in fact part of the intriguing life cycle of tiny insects. These growths—known as galls—are the home of the gall wasps' larvae.

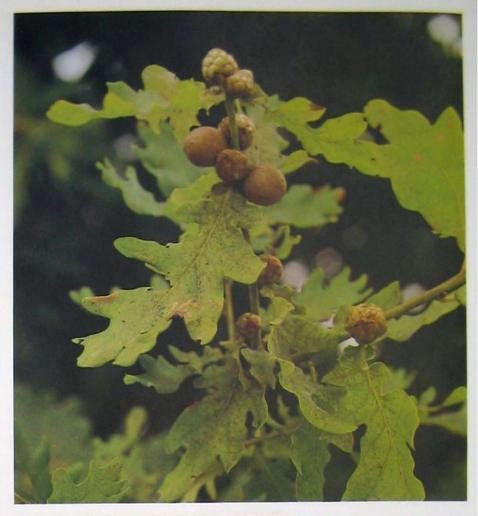
If you look closely at an oak tree you may notice that it appears to have more than one kind of fruit. In addition to the familiar acorns, there are other growths known as galls. In spite of their appearance, however, galls are not fruits; they are growths caused by parasitic insects. There are at least 30 different species of the tiny creatures—gall wasps—that thrive on oak trees in Britain.

Each type of oak gall is produced by a different species of gall wasp. You will see colourful cherry galls and spangle galls on the leaves, currant galls on the catkins and soft rosy oak apples and hard marble galls on the twigs. Galls are initially pale green, but often turn pink or reddish in colour during summer and brown or black in winter.

How galls grow The female wasp lays her eggs in a particular place such as a bud, leaf vein, flower or root, depending on the species of wasp. At the same time the wasp deposits a substance similar to the tree's growth hormone; this produces an abnormal growth as the plant cells expand or multiply. The eggs develop into grubs (larvae) which grow inside the expanding gall, each in a separate chamber. An oak apple gall has a number of chambers, while a marble gall has only a central chamber enclosing one whitish larva.

Double life cycle Oak apple galls illustrate clearly how these structures develop and the complicated life history of the insects that cause them. After mating in summer, the winged female cynipid wasps burrow down to the finer roots of the tree to lay their eggs. The resulting larvae grow inside root galls and do not mature until the autumn or winter of the following year. The asexual insects that emerge, between November and January, are always wingless females which climb back up the tree and lay their eggs in the dormant buds. These eggs are capable of hatching on the twigs of the oak tree, even though there is no male to fertilise them (ie they are parthenogenetic).

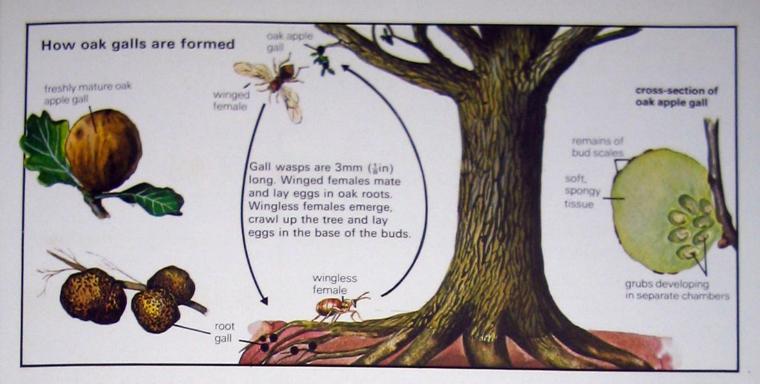
In spring the buds containing the eggs swell rapidly to produce soft, spongy oak apple galls containing many chambers where the wasp larvae develop. These larvae grow into the adult wasps that emerge from the gall





Above: Oak trees play host to a variety of galls made by cynipid wasps. These leaves carry oak apple, marble and hop-or artichoke-galls. Oak apple galls, yellowish or rosetinted then turning brown, are up to 4cm (13in) in diameter. The hard, spherical marble galls, that grow to 2.5cm (1in) in diameter, were introduced from the Middle East last century; the tannic acid in them was used in cloth-dyeing and inkmaking. The hop galls form in buds that grow to about 2cm (3in) long; their alternate spring generation is formed in the male catkins.

Left: The cherry gall is not just used by the host and guest parasites. This wood mouse happily chews it as a supplement to its diet.



in late summer, leaving numerous exit holes. This extraordinary double life cycle is not exclusive to the cynipid wasp, but also occurs in other kinds of gall-causing organisms, especially aphids.

Marble galls change from green to brown as they mature on twigs and are easy to spot on groups of small oak saplings, known as 'scrub oak', in the late summer; they are fully developed in August. The single gall wasp larva produces an asexual female in the autumn, which probably lays its eggs in the buds of the introduced Turkey oak. A tiny hole in the gall indicates that the wasp has chewed its way out; a larger, jagged hole is probably the result of a persistent woodpecker searching for the wasp grub.

Currant and spangle galls Currant galls which appear in spring on male catkins look just like red currants. The winged male and female wasps emerge and mate in June, when the female lays eggs on the lower surface of the oak leaves; each egg causes a spangle gall

to form—as many as 50 or more on one leaf; these are a common sight in autumn. The spangle galls fall to the ground and the grubs overwinter inside them, protected by layers of dead leaves, and emerge as asexual wingless females the following April. These creatures crawl up the tree to lay eggs in the male catkins and form currant galls once again.

The easiest way to study galls is to collect them in a jam jar, covering it with muslin to ensure that the galls do not become too dry and hard or too moist and mouldy. The gall wasps will eventually bore their way out, sometimes followed later by other parasites. If you cut your galls in half, you can see the different types of structure—the single chamber and wasp in the marble gall or the crowd of chambers and wasps in the oak apple.

Although oak galls are some of the most familiar growths, you also see robin's pincushion galls on field and dog rose bushes, bean galls on willow leaves, rosette galls on hawthorn and lighthouse galls on ground ivy. Guests and parasites

In addition to the gallmakers, other larvae are found in galls; these are of 'inquiline' or guest species of other small wasps, sometimes so numerous they can starve the hosts or kill them. Normally the adults do not emerge until the following year, so they can lay eggs when new galls are ready. Galls also attract parasitic wasps, the larvae of which feed on the gall wasp larvae and eventually kill them. Thus within each gall a complex community is formed.



LIFE ON WINDSWEPT MOUNTAIN TOPS

Up on the snow-covered mountain tops a small community of animals and plants has adapted to raging winds, searing cold and long, dark nights. In winter ptarmigan and mountain hares turn white and their furry feet act as snow-shoes; mice and shrews dig snow tunnels, while hardy plants cling to rocks.

In the Cairngorms you might come across a herd of reindeer, plentiful in Britain during the Great Ice Age. In 1952 they were reintroduced and now roam freely over nearly 6000 acres in Glenmore Forest Park. Unlike many creatures that seek shelter on the lower slopes, the hardy reindeer stay up on drier ground.



In the north and west of the British Isles is an expanse of semi-wilderness, quite unlike the rest of our landscape; here lofty peaks, snowcovered for much of the year, rise to a height of over 1220m (4000ft). The severe climate and steepness of the slopes means that they are still very remote: only determined climbers and skiers brave the heights. But the mountainsides are not quite as desolate as they look: a small but sturdy community of plants and animals have adapted to these harsh conditions and, hidden from sight for months by a protective mantle of snow, eke out a precarious existence.

Altitude has profound effects on climate and wildlife. For a start there are no trees, not simply because there is too little soil on bare mountainsides, but because it is too cold and windy for them. Even the hardiest trees need an average temperature of above 10°C (50°F) for at least two months of the year. At 700m (2300ft) it might just be warm enough in some places; but for every extra 150m (500ft) above sea level, the average temperature falls by about one degree. 1000m (3300ft) is well beyond the tree limit and parts of the mountain ranges in North Wales and Scotland are even higher than this.

Hardy plants Only plants adapted to alpine conditions grow above the tree line. Some grow in permanently wet places where water collects, but others face the problem of water shortage. Rain runs off rocky mountainsides and on the steepest ground there is little soil to trap the water. In winter, water is frozen as ice or snow and so cannot be used by plants. Searing wind presents a further difficulty, buffeting the plants and drying out the soil. For example, on the summit of Ben Nevis which dominates the landscape near Fort William, gales of 50mph or more blow on at

least 250 days of the year.

Many of these plants are succulents which cope with the dry conditions by storing water in fleshy leaves and stems. Rarely more than a few centimetres tall, the plants cling firmly to the rock and pockets of warmer soil. The soil is scant and poor because the hard rocks weather very slowly and release few nutrients into the soil. Lichens and mosses form thick carpets, able to withstand weeks of drying out, swiftly absorbing water from rain or snow showers. Larger plants, such as tough grasses and the low shrubby bilberry, grow in sheltered nooks, their roots anchored in cracks between the rocks. Others, such as saxifrage (which means rock breaker), form low cushions, the temperature inside the clump being higher and more stable than that outside. There are also a number of evergreens such as crowberry which can use the sun's energy for growth all the year round, even in the dim light filtering through the snow.

Snow to the rescue Snow is very cold stuff, though not nearly as cold as the mountain air which often reaches -10°C (14°F) or lower

in winter. A covering of snow actually protects the plants and soil creatures from the cold: if it is -5 C (23 F) on the surface, it may only be 0°C (32°F) underneath the snow. Frost, too, is kept at bay. When there is no snow frost freezes the soil solid and kills plants, while dry air steals away any remaining moisture. Although the growing and feeding processes of all plants are slowed down under this mantle of snow, the plants survive.

Without this plant life most of the creatures that live on the mountain tops could not survive. Tiny soil animals, such as mites, weevils, springtails and small beetles, live among the plant roots. Several of them are flightless: feeding underground they do not need to come above the surface and risk being blown away. Many, including springtails and mites, produce a glycerol antifreeze which prevents them from freezing solid. They in turn become an important source of food for larger animals, and particularly birds, which move up the mountainsides during the more hospitable summer months.

Burrowing mammals In patches of grass these animal communities are numerous enough to support pygmy shrews, both of which can be found on our highest peaks in winter. In Wales, the wood mouse ekes out a meagre living on rocky screes near the summit of Snowdon. Once the problem of food is solved, these small mammals have one big advantage over larger peak dwellers: they can escape the bitter conditions by burrowing under the snow and hiding beneath rocks.

Above the snow the creatures dependent on the vegetation must literally scratch for a living. Principal among them is the ptarmigan, a kind of mountain grouse which is rarely seen below 650m (2100ft) and is most at home on steep, stony ground. There the wind scours snow off the shrubs, exposing the shoots, berries and leaves which form the mainstay of the ptarmigan's diet. Ptarmigan have been remarkably tolerant of intrusion by skiers and mountaineers. They can be seen strutting through the snow below the chair lifts at places like Glenshee. The small black and white bird, the snow bunting, which arrives for the winter from the Arctic, has also come



The structure of mountains

A cross-section of the land reveals layers of different rocks, deposited at various periods over millions of years. There are three main groups. Igneous, such as black basalt and granite, formed from molten larva forced out from the earth's core. Much of the Cairngorms and the Wicklow Mountains are topped with granite. You can recognise it by the glinting crystals of mica, quartz and feldspar embedded in it. Sedimentary, such as limestone and shale, formed from layers of mineral sediments or the remains of plants and creatures compressed at the bottom of the sea. The Cambrians are a mixture of shales and sandstones; the core of the craggy Pennines is limestone.

Metamorphic, such as slate and gneiss, formed when igneous or sedimentary rock was changed by heat and chemical action. It is often dark, banded and wavy as a result of folding, breaking easily into flakes and sheets, as in the slate of the Welsh mountains. Most of the Scottish Highlands rocks are metamorphic.

The oldest mountains, based on gneiss, are in the Outer Hebrides and the north-west Highlands. The youngest, the Pennines and mountains of south Wales, were thrown up some 270 million years ago. Once as high as the Himalayas, the peaks have been eroded by weathering

The ptarmigan is well adapted to the snowy mountain tops: stiff, comblike feathers on its feet serve as snow-shoes, preventing it from sinking into the soft snow while its strong claws can dig out plant shoots or even a hollow for overnight roosting.

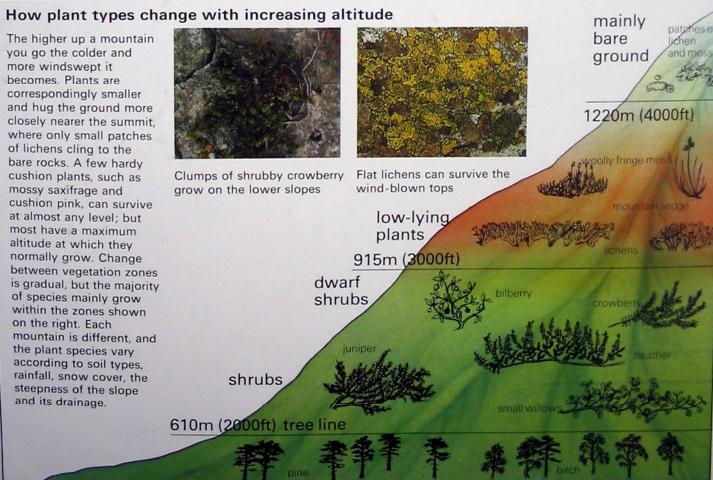
to terms with humans and now commonly feeds around car parks and from litter bins. A small number of snow buntings usually remain in the Scottish mountains to breed, building their moss-lined nests on small ledges or in rock crevices.

Winter whiteness The brown mountain hare shares a strange characteristic with the ptarmigan and stoat: its coat turns white in winter. At first sight the reason for this seems to be the effective camouflage in a white, snowy terrain. Certainly if they remained brown, as in summer, they would be highly conspicuous. However, predators are relatively scarce at high altitudes during the winter. So it may well be that a white coat primarily gives protection against cold rather than predators. White bodies radiate heat less rapidly than dark ones, so winter whiteness may be a way of conserving body heat. Temperature seems to trigger off this colour change. The colder it is in November, the quicker the change occurs. Lowland stoats, which normally stay reddish brown all winter, have been exposed to low temperatures and the coats rapidly change to white.

If you climb up a mountainside in the winter months the only evidence of living creatures you may see is an occasional track—perhaps that of a hare or a ptarmigan. Most of the resident wildlife will be sheltering under the snow or in rock crevices, protecting themselves from the cold and wind.



The mountain hare, smaller than its lowland relative the brown hare, moults from brown to white as winter approaches and retains its white coat until spring. The Irish mountain hare, however, only develops a piebald coat or does not change colour at all. In winter the mountain hare feeds almost entirely on heather but will eat the twigs of willow or birch if the heather is covered in very deep snow.





ON THE FOX'S TRAIL

Most young dog foxes leave their parents' territory in autumn. By spring they should have found their own patch, but some become 'homeless' bachelor travellers. As dawn breaks across a frosty hill-top, the countryside seems bleak and empty. But where the wind or sun has not removed the previous night's tracks, the whitish crust is broken by a line of prints—each one oval and each threaded to the next by a scuffed line, where a bushy tail has been dragged along.

The tracks are unmistakably those of a fox. Where the same trail is followed twice in heavy snow, the same footprints are used—an economical way of moving in otherwise tiring conditions. The criss-cross of tracks shows that by night both predator and prey were about, each set of tracks telling a story; how a vole dashed into a snowy tunnel as the fox dug frantically behind it; or how the

The fox is acutely aware of its surroundings: it has a strong sense of smell and its pointed ears are sensitive scanners. It is, however, unlikely to spot you if you keep perfectly still. The eyes are better adapted for night vision and nocturnal hunting.

fox tackled a meal of a sheep's carcase. If you learn to read the fox's tracks in snow, sand or mud, you can begin to gather clues about its night-time activities.

Population problems Winter time is a difficult season for foxes. Growing cubs have either left their parents' home territory or are competing for a place in the community. Either way, the population has been doubled or even trebled by maturing youngsters. Inevitably many will have died by the spring at the hands of man-mounted horsemen out hunting, commercial trappers after pelts, farmers worried about their livestock, gamekeepers protecting their birds or local authority officials concerned about possible health risks. Although in theory foxes could live as long as dogs-about 10 years-they rarely do. The majority die before the end of the first winter and, in most places, few survive a third year. Where foxes are not harrassed by man, the population contains more older animals and consequently a more stable society emerges.

The teeth of dead foxes obtained from hunters in different parts of the world have been examined to find out their average age. The fox's tooth is treated with acid to remove the hard calcium. Thin sections of the tooth are then cut and stained for examination under the microscope. The stain reveals lines around the tip of the root; these are annual growth rings, similar to those that signify the

age of a tree or shell. These studies have confirmed that of the hunted animals, most were younger foxes.

Territories and travelling In winter the snowy tracks across the hill often reveal that the fox has travelled huge distances by night. Sometimes the tracks lead up hill and down dale in an unrelenting straight line; this probably indicates that the fox that made them was a maturing male, looking for a mate and territory of his own.

Most young dog (male) foxes seem to leave their parents' territory in autumn. Sometimes they do not leave immediately, but make evermore lengthy excursions into the neighbouring countryside. It is not clear whether the young foxes make these excursions—or eventually depart altogether—because they are driven out by their father or because of some inborn urge to leave the territory in which they were born. Dog foxes normally travel further from their birthplace than females do, so the risk of inbreeding is reduced. Some vixens, perhaps many, do not disperse at all. Instead they remain in their parents' territory for their entire life.

Just how fox society works still provokes much debate. One thing, however, is certain: foxes are very flexible in their social ties. They can live successfully in many varied habitats by adapting to local conditions.

Members of the community usually fall into two types. The territory-holding animals

Contrary to popular belief, foxes are not totally solitary animals. Where they live in groups, they cohabit happily. These two young foxes indulge in mutual grooming.



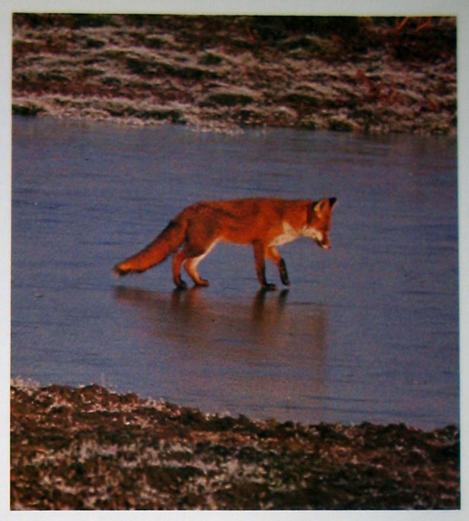
live for long periods in the same patch and defend their borders from neighbouring foxes. The size of the territory can vary from as little as 25–50 acres to well over 250 acres. The resident foxes sometimes live in pairs, but a single dog fox can join with several vixens to form a larger group when food is plentiful and harrassment by man is infrequent. Much of the evidence suggests that such cohabiting vixens are close relatives, perhaps mother and daughter or sisters. At night these foxes cover almost exactly the same area and their routes often overlap, depending on the local food supply. The foxes, however, travel independently and not in packs.

Where the habitat provides enough food and shelter for foxes, it is more likely that a young vixen in her first winter will be able to stay at home. If an elder sister or her mother dies in the autumn, the youngster can fill the vacancy in the group. By doing so she avoids all the risks of travelling across unknown country in search of a vacant territory—and perhaps not even finding a vacancy.

The second type of fox involves the more foot-loose itinerants (usually young dogs) who do not seem to have a patch of their own and who travel relatively large distances. Not only do they trespass on the territories of resident foxes, but they are often also the victims of the huntsman and his hounds because they are travelling across unfamiliar territory. Traps and snares can also catch them unawares. Little is known about these travelling foxes because they are so hard to study—even with the most sophisticated techniques such as radio-tracking.

Fox-talk Foxes have a wide vocabulary of noises and each call can be made with a variety of pitches. A night spent in a woodland in winter listening to dramatic fox choruses will convince any sceptic that foxes have a complicated system of communication. Foxes make noises throughout the year, but reach their peak in mid-winter.

Each call probably serves several functions. It may enable the caller to identify itself and its position, or communicate with other members of the caller's group—its neighbours and rivals, offspring and mates. There are



four recognisable types of fox calls. Perhaps the one most frequently heard is the 'wowwow-wow' call, the repeated syllables of which trail eerily into the night, often to be answered by another fox. On some occasions, when this call fluctuates, the fox is clearly moving.

A second type of call is the screech—often known as the vixen's scream, although dog foxes also make this noise. Many countrymen believe vixens make this call when they are on heat to attract males. But it still remains a mystery and a frequent source of alarmed telephone calls to the police from householders who fear some hideous crime is being committed in their back garden.

The fox is a most adaptable and enterprising British mammal; few other species would probably follow this fox as it walks gingerly over the ice. The tracks and brush line left along the ice and surrounding frost would be clear evidence that a fox had passed through this area.

Finding foxes

Although they cloak their movements in darkness, foxes leave plenty of signs for the sleuth.

Smell The most obvious is the rather acrid smell of urine which occasionally hangs above a woodland path or glade and can normally be traced to a tussock of vegetation, which may be topped with fresh droppings. These droppings are generally left on top of open sites, as they are part of the fox's scent-marking vocabulary. They can be distinguished from those of dogs by the rather sweeter smell, the obvious presence of bone chips,

insect shells, traces of fur and feather and sometimes by curly pointed ends.

Footprints can best be followed in snow. The edges of puddles or ditches, however, can also yield clues. The fox's footprint is oval, about 6cm (2in) long and 4cm (1½in) wide (depending on the softness of the mud); dog tracks are rounder. The two front claws of the forefeet normally leave pin-prick impressions close together, where dogs' claws would be more spread out. The tracks of some dogs, particularly sheepdogs, can be very fox-like. A trotting fox travels in a straight line and in snow leaves tracks stretching out like a necklace.



The geography of a fox territory

A family group of foxes will confine most of its hunting activity to its home territory—which in this illustration is an area of farmland with plentiful food supply. During one night foxes may travel many miles criss-crossing their home range in search of food. The size of this area and the size of the group will vary depending on the amount of food available.

Key

/

boundaries for part of the territory of a family of four foxes



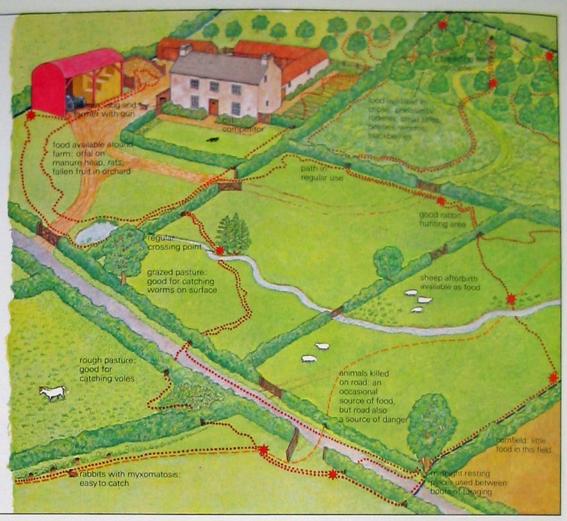
some movements of the fox family during one night



places where droppings have been deposited



movements of a young dog fox without a territory



To hear the other types of fox noise, the eavesdropper needs to be close at hand, since the noises are made when foxes are in contact. One is called gekkering, a mechanical staccato noise which sounds similar to the clicking noise made by a football supporter's rattle. This noise is sometimes called clicketting and the word may also be used to describe the foxes' mating season, when squabbles involving gekkering can be heard. Often interspersed with gekkering is a collection of whines and whimpers which can be heard when foxes greet each other, or when dominant foxes bully subordinate ones. Foxes almost never growl and, unlike the stuffed specimens in glass cases, they never snarl.

Scent and sex Another form of communication between foxes—scent marking—is also best seen in the winter's snow. If you follow a set of tracks across the snow, it probably won't be long before you find a snow-covered tussock or mole-hill with signs of a sprinkling of urine. Both vixens and dog foxes go in for this sort of lamp-post annointing, just like male dogs. You can follow two sets of fox tracks and find that each time one fox has made a mark with urine, so has the other.

These tracks mirror the behaviour of a courting pair, with the dog fox marking over the scent of his vixen. When the two eventually mate they will lock together like dogs for up to half an hour. The vixen is only receptive

for three or four days a year and so during that period the dog fox follows her incessantly. Once they have mated, contact between the two becomes less frequent until spring when the business of cub-rearing begins.

Because few people have been able to watch foxes mating, little is known about the behaviour involved. Some have stumbled over a mating pair which were alone in the woods, while others claim to have seen a vixen followed by several males, sometimes a line of them following her scent. One suggestion is that the vixen will mate with only one dog, while another theory is that several dogs will mount her.

Much remains to be learnt about the role of the male in fox society, and this applies also to the travelling male. To understand what the travelling fox is up to necessitates knowing not only about its family circumstances 'at home', but also about all the foxes it meets as it travels—and, most important of all, the foxes in the place where it eventually settles. Does it, for example, have to find a territory where one male has died, thus leaving a vacancy, or can it oust a weaker or ageing male? The resources and manpower required to answer such questions are so great that the bachelor fox's secrets are secure for the time being.

Later articles deal with the rearing of cubs, family life, the fox earth, diet and the urban fox.

FOX (Vulpes vulpes) also called Reynard Size Dog (male) head and body 67cm (25in), tail 38cm (15in), weight 6.7kg (14lb). Vixen (female) slightly smaller and less heavy Colour rusty brown to red above, dark grey to white below. Back of ears and points of limbs dark or black. Tip of tail may be white, but presence or absence is no indication of age or sex. Variously prominent dark face markings may be present. Overall 'speckling' from black/ yellow/brown guard hairs. Breeding season Late January. Cubs born in late March, but this varies up to a month before and after Gestation period 52 days Number of young 1-10, with an average of 4-5 Lifespan 2-3 years, with maximum around 10 years Food Hares, rabbits, mice, voles, small birds, fruit, insects, earthworms, carrion Predators man-farmers, sportsmen, gamekeepers, trappers, local government officials concerned with foxes as disease-carrying pests Distribution throughout mainland Britain (not in some islands like the Hebrides)

THE HORSE CHESTNUT: TREE FOR ALL SEASONS

The dazzling flowers of the white horse chestnut are a sure indicator of summer. Perhaps more than any other tree, the horse chestnut vividly reflects the changing seasons: the fat sticky buds of winter open in spring to reveal downy green leaves, and shiny brown conkers litter streets and parks in autumn.

The horse chestnut in May—a cascade of brilliant white flowers. The tallest specimen in the British Isles—38m (125ft) high—is at Petworth House in Sussex.





White horse chestnut (Aesculus hippocastanum)
Deciduous, introduced, grows to more than 30m (100ft), lives up to 100 years. Cultivated in parks and gardens, occasionally grows wild, on rich well drained soils.

The white horse chestnut is an impressive tree at any time of the year—and in flower it is truly magnificent. With its wide-spreading branches and typically rounded crown it presents a towering mass of luxuriant foliage throughout the summer and a glorious blaze of colour in early autumn.

Growing wild in hilly regions of Greece, Bulgaria and Iran, the horse chestnut was introduced into Great Britain early in the 17th century. Since then it has been widely planted as an ornamental tree in gardens, parkland and often in long avenues. The horse-chestnut avenue in Bushey Park, Hertfordshire, is a fine example which in Victorian times drew large crowds to admire the trees

in flower. It is also planted in and around fields to provide shade for farm animals. The foliage is palatable to cattle and horses who stretch to eat all the leaves they can reach while sheltering beneath the tree. The base of the crown forms a conspicuously straight line parallel to the ground.

A curious feature of the horse-chestnut is its slowness to establish itself in the wild, despite its apparent adaptability: it is a hardy tree able to grow on most soils and its seeds (or conkers) germinate freely, yet it seems unable to compete easily against many of our native plants which often crowd it out. This is in stark contrast to other introduced species, such as sycamore, which spread rapidly into woods and plantations.

It is impossible to confuse the white horse chestnut with any other tree, including other chestnuts. The red flowered horse chestnut, which is less widespread, is a result of a cross between the common species and red buckeye, a native of North America. It differs by having red flowers, smoother fruits and generally smaller leaves. The totally unrelated sweet chestnut is clearly distinguished by its yellow flowers, spirally-twisting bark, long saw-edged leaves and more spiny fruit cases.

Bark and timber The horse chestnut's greybrown bark, which is initially smooth, becomes rough and scaly with old age; the oldest dated specimens in this country were planted in 1664. The tree itself is of little Left: The horse chestnut bears up to 100 male or bisexual flowers on each candle. The centres of each flower change from yellow to red after pollination.

Below: Under the spreading horse chestnut in autumn you find golden leaves—the largest of any tree in Britain—and conkers that children use in the game originally known as 'conquerors'.





practical value. The cream-coloured wood is soft and weak, making it unsuitable for most purposes, although it is used to make toys and trays. It does not burn well; but in medieval times its charcoal went into the manufacture of gunpowder.

Sticky buds The fat buds, which form during the previous summer and are so prominent in spring, are coated in shiny resin; this protects the new season's shoots from attack by insect pests. The sticky resin gums up these insects, immobilising them and preventing them from chewing into the delicate buds.

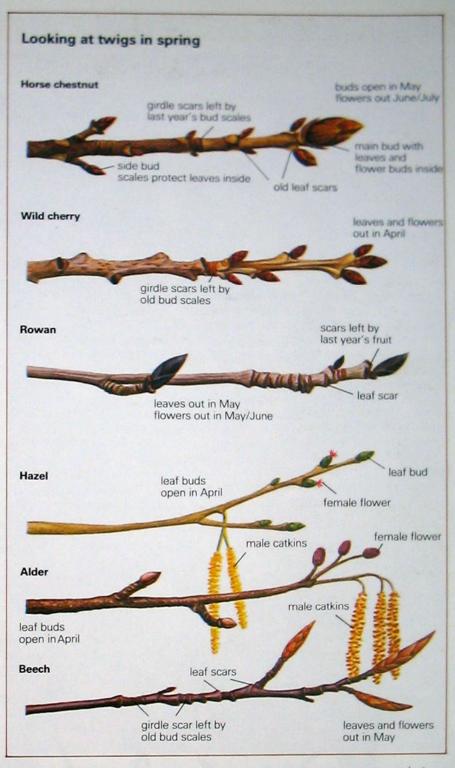
If you collect the winter twigs in bud and place them in a jar of water, you can watch the buds burst into leaf. In early spring the buds swell and break open on the tree, the bud scales peeling back as the growing tip emerges. The young leaves are pale green and clothed in white, furry down which gives protection throughout the winter, although the down is soon shed as the leaves expand. Large horsehoe-shaped scars are left on the twigs where previous years' leaf stalks were attached.

The leaves are among the first of any tree to appear in spring and also among the earliest to colour and fall in autumn-changing to yellow and deep gold before dropping. Growing up to 20cm (8in) across, the largest leaves of any tree found in Britain-indeed in Europe—they are made up of from five to seven pear-shaped leaflets borne on a long, stout stalk. When the tree is in full leaf it forms a dense, shady canopy which shows beautifully how leaves can be arranged to reap the maximum benefit from incoming sunlight. Moreover, the leaves can twist on their stalks during the day and position themselves to catch the sun, so avoiding being shaded by their neighbours.

Candles The flowering spikes, or candles, blossom in mid-May, although they emerge earlier with the young leaves. Made up of four or five petals, the white flower is tinged with yellow blotches that turn red after the flower is pollinated. Hard-working bees pick up and transfer pollen from the seven red-tipped stamens that protrude from each flower to the stigmas of other flowers. Two other horse chestnuts, the Japanese and the Indian, also have white/yellow candles. The Indian flowers later than the white horse chestnut.

Conkers form inside a tough, spiky capsule and are protected by a lining of soft white padding; as they ripen they change colour from white to rich, glossy brown by early October. If they do not fall with the capsule, or are not knocked down with sticks thrown by children, they will be released as the three segments that make up the capsule dry and peel away from the swelling seeds. During October most playgrounds and classrooms become littered with broken horse chestnuts, the aftermath of energetic conker duels—a game first popular in the 19th century.

It has been suggested that horse chestnuts



were so called because the conkers were a remedy for horses with a cough. This is, in fact, unlikely, for horses refuse them owing to their very bitter taste; but deer and sheep will eat them.

Protect a tree As has been mentioned above, horse chestnuts may germinate and then soon become overwhelmed by other vegetation. However a sapling usually flourishes if it is moved to deep, preferably loamy, moist but well-drained soil and a sunny position. Keep it free from smothering plants and protected from livestock and it will have a good chance of survival. And you will have contributed another beautiful summer sight for the next generation to enjoy.

Even before the leaves of broadleaved trees appear, you can identify a tree by the marked characteristics of the twigs. Look at their shape and colour, the position of the buds, their distinctive markings—old leaf scars and 'scale-scars' from old buds. The distance between one scale-scar and the next tells you how far the twig has grown in length in a year.

THERE IS MORE TO FLOWERS THAN THEIR **BLOOMS**

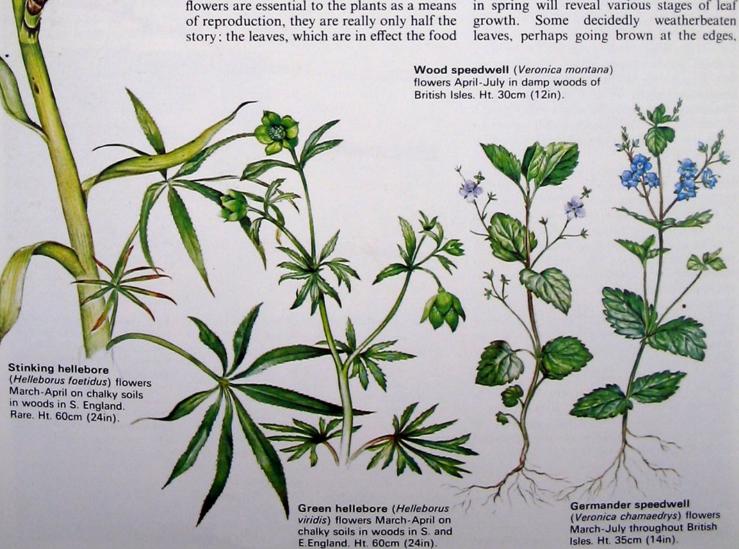
It is easy to look at a beautiful flowering plant and scarcely notice its leaves. In fact the green leaves are just as essential a feature of the plant as the flower itself, and are sometimes as beautiful. They are the plant's food factories, and come in a great variety of different shapes and sizes.

Spring arrives as the days become longer and lighter, if not yet convincingly warmer. The occasional insect visits an early flower, frog spawn appears in ponds and ditches, willow and hazel become festooned with catkins, and in the woods and hedgerows most of our wild plants undergo a burst of growth after their winter rest.

The plants use up food they have stored in their seeds, stems and specialised organs like corms and bulbs; when the leaves appear in early spring they provide the food necessary to manufacture flowers later on. For although flowers are essential to the plants as a means of reproduction, they are really only half the factories of the plants, are the other half.

Food factory A leaf is a well-organised structure, with a network of veins to provide its cells with water and an air supply system from its surface pores (stomata). Close-packed green cells trap energy from the sun; the surface pores allow in carbon dioxide from the atmosphere, combining it with water rising from the roots of the plant; from this combination the cells make the sugary food reserves from which the plant grows and flowers form.

A quick examination of the undergrowth in spring will reveal various stages of leaf growth. Some decidedly weatherbeaten



have obviously been through a whole winter and represent last year's growth: the evergreen leaves of the perennial stinking hellebore, which provide a slightly tatty backdrop for the greenish flowers, are like this.

Some annual plants, a few of the speedwells for instance, produce a small number of new leaves during winter which, depending on their age, look quite ragged by springtime. Others only have new leaves, bright green and tender, like those of the green hellebore, which appear with the flowers in March but die before the following winter.

So, when you might expect all plants to keep some leaves during the winter to manufacture more food supplies on the odd sunny day, why is it that some like the green hellebores lose their leaves completely? The answer is partly to do with dehydration: water is constantly evaporating through the leaf, especially via its pores, and when the soil is frozen no water is available to make up this loss. A number of our wild plants can withstand such conditions but many, such as green hellebore, find it better to shed their leaves in autumn and grow new ones when winter is over. Plants also lose their leaves as a way of disposing of their waste products.

Because drying out is often a problem, plants have evolved several ways of reducing water loss. Many, such as lungwort and forget-me-nots, have hairy leaves; the hairs trap a layer of air which slows down evaporation. Other plants, such as holly and stinking hellebore, have a particularly thick, waxy leaf covering which is very effective as water-proofing. In really dry situations leaves may be dispensed with altogether. So plants such as butcher's broom have green stems, which have taken over manufacturing food, and have a relatively small surface area to minimise water loss.

Leaf or leaflet? When you start to look closely at leaves you realise that they come in nearly as many shapes and sizes as flowers; this means they can be almost as useful as a method of identification. They range from simple ovals, like those of lungwort, to the lacy, divided structure in anemones and yarrow. With some plants, such as hellebores and horse chestnuts, it can be difficult to decide whether you are looking at a cluster of separate leaves or a single leaf divided into many segments. In these cases you must look for the axillary bud, a small knob of tissue in the angle between the leaf stalk and the plant's stem which will eventually grow to produce a branch or flowers. Every true leaf has one. Although there are no buds at the base of the individual leaflets of hellebores and horse chestnuts, there is one at the base of the stalk to which they are attached. So you can deduce that the whole structure must be a single, compound leaf made up of a leaf stalk and several leaflets.

In many plants, such as wild pansies, violets and willows, pairs of leaf-like append-



ages called stipules can be seen at the base of a few or all of the leaves. In some plants, such as pansies, they are attached to the leaf stem; in other plants, such as lungwort, they are scale-like and surround the leaf stem. Most of these appendages function like bud scales, helping to protect the leaf in its younger stages. Some stipules may also function as leaves.

Flowers also tend to have leaf-like or scalelike structures called bracts. They are often fairly small, though some plants such as hellebores have large bracts at the base of their flower stems which look like true leaves. Bracts probably help to protect the young female flower buds and, like stipules. The rare stinking hellebore was given to children in the Middle Ages as a cure for worms. Highly poisonous, it led Gilbert White, the 18th century naturalist, to exclaim: 'Where it killed not the patient, it would certainly kill the worms; but the worst is, it will sometimes kill both'.

Lungwort (Pulmonaria officinalis) flowers March-May in woods and hedgerows of England and Scotland. Rare. Ht. 30cm (12in).

Right: Toothwort lives off the roots of hazel and elm. It was sometimes known as the corpse flower because people believed it grew from a buried corpse.





those containing chlorophyll may also function as leaves by making food for the plant.

The tough, spiny 'leaves' of butcher's broom are even more confusing because they are not leaves at all. Each one bears a greenish flower centrally on its upper surface, something that a true leaf would never do. This 'leaf' is in fact a short, flattened, leaf-like branch known as a cladode. The true leaves are reduced to little scales on the main branches of the plant and the cladodes have taken over the food-producing function.

Parasites Perhaps the most remarkable flowering plants, however, are those that have become parasites. With these the leaves no longer manufacture food because the host plant supplies the parasite with all its requirements. Toothwort is a parasite which lives on the roots of many woody plants and steals their food supplies. With no need to trap sunlight to make its own food, it has lost its green pigment and is white or pinkish in appearance. And since its leaves are redundant, they have become more fleshy, tooth-like scales on the creeping underground stem. These scales have not only given the plant its name, but also led early herbalists to believe that the plant was a good remedy for toothache. The appearance of the leaf and its resemblance to the afflicted area were held to be a clear indication of the plant's medicinal properties.



Downy cygnets take to the water early and are guarded carefully by their parents, who pull up underwater vegetation for them. It has been suggested that the adults also paddle vigorously to bring food to the surface for the young.

ARISTOCRAT OF THE WATERWAYS

The mute swan that once graced the tables of medieval banquets is now protected from this fate. It is, however, vulnerable to the modern hazards of overhead power cables and lead weights in fishing tackle. Despite its name, the mute swan will snort and hiss noisily if it feels threatened.

You will find mute swans wherever there are sizeable expanses of relatively still water. These majestic birds are at home on slow-flowing rivers, lakes, gravel pits, large ponds—even in heavily built up areas such as London, where they add a touch of serenity to stretches of the Thames. Their haunts are not, however, restricted to freshwater, since they also frequent harbours and estuaries and have been sighted as far offshore as the Solent on the south coast of England.

Striking appearance The mute swan is one of the most easily identifiable of British birds. The adult's plumage is pure white and the thickly feathered neck is long and curves in a graceful 'S' shape. The head is small with a

down-pointed, orange-red beak tipped with a black nail, and there is a black knob over the nostrils at the base of the bill; this knob is more pronounced on the male than the female—and most obvious in spring. The webbed feet are black. The young swan has a greyish plumage which begins to turn white during the first winter and becomes pure white by the third spring, while the beak takes two years to assume its bright orange-red colour.

The swan uses its long neck to feed on underwater plants; pondweed and semi-aquatic plants make up the bulk of its diet. It also eats algae and shore plants and occasionally will take worms, insects and fish; it swallows grit and fine gravel for

Mute swan (Cygnus olor) Length (bill-tip to tail-tip) 152cm (5ft); weight—cob (male) 12-20kg (26-44lb), pen (female) slightly less; distribution; on most slowflowing waters.



Taking to the air

An adult swan is too heavy to take off from a standing position. To gain momentum it runs along (on land or on the surface of the water) with its neck outstretched and its wings thrashing violently. In a strong wind, it may have to run as far as 100m (300ft) before taking off. In flight the wing beats make a loud rhythmic noise. In order to land, the swan slows itself down by spreading out its wings and using its feet as brakes.

roughage. In deep water, where its neck is not long enough to reach certain food, it upends like a duck.

Its calls are quite out of character with its name and appearance, since it will snort, grunt and hiss threateningly when provoked; it also gives a shrill, trumpet-like call—particularly to the young who reply to the adult in a high-pitched tone.

Mating breeding and nesting Mute swans pair up, often in the autumn, when they are between two and four years old. Paired swans are not gregarious, preferring to nest isolated in their own aggressively defended territory. Non-breeding individuals and those of prebreeding age may congregate together in areas where there is plenty of food and space. In spring, when their courtship and mating rituals reach a peak, you can see a pair of swans facing each other, swaying their heads sideways or dipping their heads in the water, extending their necks and bills vertically and even upending. Once the pair has been established, the cob (male) and pen (female) return annually to the same territory to breed again. Swans seldom change their mate, unless they fail to breed.

The cob selects a nest site close to the water's edge and well away from other nests. Building the nest is mainly the pen's task, although the cob helps by gathering vegetation, often from previous nests, and passing it to her. The pair makes little attempt to camouflage the nest, which is a huge pile of reeds and sticks lined with a thin layer of down.

The pen lays her chalky, round-ended eggs every other day for up to 12 days; this occurs any time from April to July. The pen does most of the incubating, although the cob will take his turn and keep guard over the nest.

The eggs hatch after 36 days and the pen carries the broken shells to the water's edge. The young, which are born with their eyes open, are covered with soft, fur-like grey down; this is replaced by woolly feathers which change slowly to a drab brown colour. At five days they are independent enough to leave the nest during the daytime, although for up to a month they may continue to gather

in the nest at night. Cygnets will walk long distances to water, marching along in single file behind their parents. If you are lucky, you may see one riding on its parent's back between the arched wings. They fly at four months and are usually driven away from the nest area in the following spring, when their plumage has changed from grey and when territories are redefined and their parents begin to prepare for the next brood. After leaving the nest the young join the summer flocks of non-breeders until they are ready to mate.

Less than half the swans in the British Isles are breeding stock. You can easily identify the non-breeders, which are immature birds or those which have yet to form a nesting pairs, since they have pale pink bills and small nostril-lobes.

Moulting and migration If you come across a scattering of white feathers in July or This mute swan is in aggressive mood as it protects its eggs (which lie in the large platform nest of reeds and sticks) from intruders. The wingspan can reach 2m (7ft).





August, do not assume this is the result of a fight; swans moult their flight feathers in the summer after nesting. When moulting they are vulnerable because they cannot fly.

Some breeding adults, whose young cannot yet take to the air, moult at the nest site, but most make long journeys to find a safe place where they will not be threatened during the flightless period. Up to 1000 swans arrive annually on the River Stour in Essex to moult while others use Fairburn Ings in Yorkshire, the Tweed estuary and Loch Leven in Kinross. They moult 15 to 30 days after arrival, losing first their primary feathers and then the secondaries. They are able to fly again after a month, four weeks before the feathers have reached full length again. The return journey is made in September or October.

Swan ownership The mute swan is frequently described as a royal bird, and in fact all swans were once proclaimed to belong to the Crown, just as forests were reserved for royal deer hunting. Noblemen and city guilds were also given a right to own swans; a marking system of cuts and nicks on the swans bill was used to identify the ownership of each bird.

Today the Dyers and the Vintners City of London livery companies are the last lawful owners (apart from the Queen). The Dyers use a single nick on the side of the bill, while the Vintners use two. The Queen's birds are not marked at all. This ownership of swans is taken as applying only to the Thames; elsewhere swan populations are unmarked and are treated as wild birds.

Swan upping Each July the colourful ceremony of swan upping—when the cygnets are rounded up and marked—takes place on the Thames. Three groups of swan uppers—one from each livery company and one led by the Queen's swanherd—row for four or five days up the Thames, from Maidenhead to Pangbourne, herding each brood of cygnets and marking them according to the marks found on their parents.

Threats to the swan The swan has no serious natural predators, although foxes and pike will sometimes take unguarded cygnets; and pike have been known to drown adult swans by holding their heads under water. The only real threat to the swan comes from man's increasing encroachment on its natural habitats. Overhead power cables are a major hazard to swans in flight and a number also die every year from oil pollution and mercury poisoning.

An increasingly common cause of death, which is currently under investigation, appears to be lead poisoning. Swans often become entangled with fishing tackle and swallow the angler's lead weights. They also swallow lead shot and fishing hooks which have been discarded in the water at the end of the fishing season—a worrying result of modern disposable fishing hooks, lines and weights.

An adult swan that is fortunate enough to escape all those threats to its life, however, can live up to 15 years and sometimes even longer; but on average a swan that succeeds in fledging will only survive for two to three years.

The mute swan establishes a territory at the start of the breeding season and defends it aggressively, driving away intruders with a threatening display or, as here, by chasing the other bird off its patch.



The mute swan's head is small compared to the rest of its body. The down-pointed, orange-red beak is tipped with a black nail. The characteristic black knob over the nostrils does not develop until the bird becomes fully mature.

EVERGREEN WOODLAND FERNS

Ferns are some of the world's most primitive plants. In the British Isles you can find more than 50 species, growing in damp woods, hedgerows, cracks and crevices, on trees and even in drains.

When everything else seems dead and brown the graceful fronds of evergreen ferns give a lushness to the undergrowth of winter woods in a way that no other plants do.

Ferns are an ancient group of plants dating back 400 million years to the time before flowering plants and trees evolved and before mammals and birds existed. Ferns appeared at about the same time as clubmosses and horsetails; they adapted to life on land, evolving roots in order to absorb water from the soil.

Ferns, clubmosses and horsetails were probably the first true land plants. They transported food and water in strong, woody vessels which gave their stems a stiffness so that they were able to grow tall. Many ferns grew to tree-like proportions, developing enormous leaves that spread out from the top of the trunk to catch the light. A few of these types of tree-fern still exist today in tropical rain forests, some as tall as 20m (66ft), but in prehistoric times vast areas of land were covered by tree-fern forests.

When plants with flowers and seeds developed, about 180 million years ago, they eventually took over the ferns' dominant position for the simple reason that they did not depend on moist conditions to reproduce. Ferns have always had one drawback; however resistant to dryness their mature leaves may be, there is a short stage in their life cycle when they are so small as to be almost invisible and they must be submerged in a film of water for fertilisation to take place. Flowering plants thrive without this essential aquatic requirement and so they multiplied, different species flourishing in every extreme of climate, while ferns dwindled in numbers.

In the British Isles ferns now grow most successfully in humid areas, often where there is not much light, since they tolerate shade better than most flowering plants. They are small in comparison with their tree-like ancestors. They were popular here as garden plants in Victorian times; but with overpicking as well as increased air pollution from industry since then, many species have become quite rare.



How do you recognise a fern? Many leaves which people call ferns in fact belong to flowering plants, such as the delicate asparagus 'fern' leaves sold by florists. The easiest way to recognise a true fern is to look at the way its leaves unfold. They start off rolled up tightly like a coiled rope; as they grow, the tip remains curled over and it is the last part to unfurl.

Instead of developing flowers, ferns produce tiny spores on the underside of their leaves. These spores form regular patches of different shapes—elongated in the hart's tongue fern, for instance, or rounded in others such as the shield fern.

Some ferns bear their spores underneath

Hart's tongue fern growing in Dorset. Its presence often indicates chalky soils. Ferns thrive best in undisturbed damp woods where they find the moisture that is essential for their reproduction.

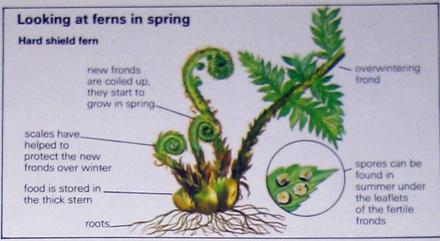
all their leaves. Others have special leaves set aside for this purpose; the hard fern is one of these, producing spindly, upright fertile fronds in the summer that are covered underneath with rusty brown spores. These narrow fronds look rather like a fish's backbone, and in Cumberland the species is known as the herringbone fern. By winter the fertile fronds have died down, leaving the spreading sterile green leaves.

Shield ferns also remain green in winter. The hard shield fern has large, rigid, prickly-looking fronds and the soft shield fern arching, feathery leaves. Black spleenwort is smaller with bright green, much-divided leaves that are triangular in outline and have distinctive black central stalks. You find it straggling over rocks, boulders and walls, connected by a long frond-stalk to its root

stock hidden in a deep crevice.

Hart's tongue fern is very different: its strong leathery leaves seem hardly like a fern at all—more like a dock leaf. Even less feathery and fern-like are the thin (just one cell thick), wet, translucent leaves of the little **Tunbridge filmy fern**, probably the most difficult of all ferns to find. It hides from the light, creeping over rocks and tree trunks near waterfalls.

This fern was once quite common in parts of Kent (as its name suggests), but collectors in Victorian times dug it up so enthusiastically that it can no longer be found there.





Left: A beech woodland floor in spring showing the darker green sterile fronds of the hard fern; the spindly frond growing at the back of the plant is one of the new season's fertile fronds. The paler green more feathery fronds belong to the lady fern.



SURFACING FOR SPRING

In spring snakes, lizards, frogs, newts and toads emerge from the various hiding places into which they retreated five or six months beofre-and sometimes in mixed groups-to survive the winter cold.

Reptiles and amphibians are cold-blooded creatures. This does not mean that they are immune to the cold but that their internal temperature fluctuates considerably depending where they are, the time of year and how much food is available. In summer they alternate between basking in the sun to keep warm (although if it gets too hot they will seek the shade) and foraging for food to keep up their energy levels. Lizards feed on insects, grasshoppers and spiders; frogs, toads and newts eat slugs and snails and a variety of

In the tropics snakes, lizards and amphibians can stay active all year round. In the British Isles where winter brings little warmth and dwindling food, they become increasingly sluggish and therefore vulnerable to predators. In order to survive they must spend

the winter in shelter or underground in a dormant state, to conserve their energy. If they stayed exposed above ground over a long period they would certainly freeze to death.

The length of this period of inactivity varies with the species and also differs from place to place. Adders in western Scotland for instance start to seek shelter in early October, whereas adders in the south of England (where it is generally warmer) do not become inactive until late October or early Novemberalmost a month's difference. Common lizards, slow worms and grass snakes usually go underground about mid-October, while sand lizards and smooth snakes probably disappear a little earlier. Frogs, toads and newts usually suspend activity in October or November.

Choosing a hideout The common lizard capitalises on the remaining days of summer to build up substantial reserves of energyrich fat, storing much of it in its stocky tail. Thus fortified it seeks its winter retreat.

The adult females are the first to retire. followed by the males and lastly the juveniles. Sand lizards may dig their own winter hideouts, but other reptiles search out disused burrows or other dry holes in a bank or settle under stones, logs or the roots of a tree. Overwintering reptiles are therefore hard to find. In Scandinavia where the ground freezes hard in winter, adders have been found up to two metres (6ft) below ground.

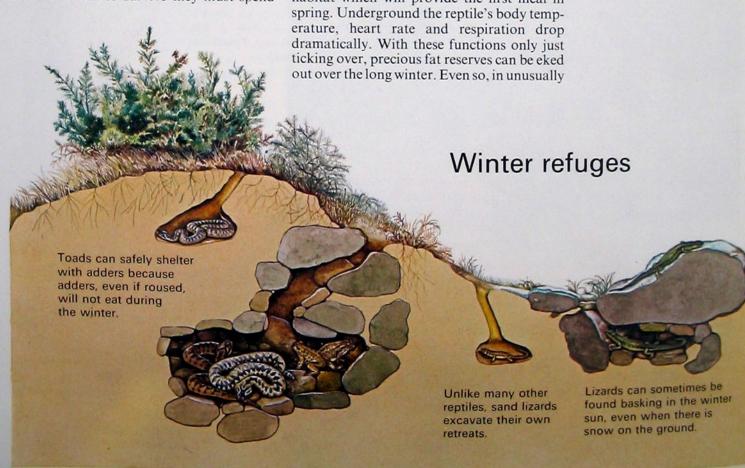
The entrance to a reptile's retreat will often have a sunny aspect and usually adjoins a habitat which will provide the first meal in

Amphibians

Frogs, toads and newts are amphibians, which means they can live on land but have to breed in water because the young (tadpoles) only take in oxygen through gills. Our six native species are: the common newt, crested newt. palmate newt, common toad, natterjack toad and common frog. The edible frog and marsh frog were introduced from Europe.

Reptiles

Snakes and lizards are reptiles and have a protective scaly coat which they can shed or slough. There are six native species. the three lizards are the slow worm, sand lizard and common (viviparous) lizard. The snakes are the adder. grass snake and smooth snake.



harsh conditions many reptiles and amphibians die.

Most frogs (and some newts) submerge under water and bury themselves in the muddy bottom of a pond or ditch. Frogs have lungs; when on land they can breathe in air through their nostrils, but underwater they have to absorb sufficient oxygen through their skin. All toads, some newts and a few frogs look for a dry land refuge, such as a mouse burrow, the warmth of a compost heap or even a dark cellar or garden shed.

In Britain, winter withdrawal is rarely uninterrupted; both reptiles and amphibians can shake off their torpor to surface and bask on a sunny day, even with snow on the ground. Where the occupants are a mixture of species they may sunbathe together, but they do not look for food. The adder, for example, has no appetite for the lizard which, in the middle of summer, it would regard as fair game.

Spring awakening Emergence, which takes place in early spring, is a gradual process, initially confined to the middle of the day when the sun is hottest. At first reptiles and amphibians do not stray far from their winter retreat and their sorties are brief and laboured. Common frogs usually surface in March, but this can vary from January in Cornwall to as late as April in the high moorland regions of the northern Pennines. They sometimes get an unwelcome shock when they wake up in a late cold spell and, emerging from the mud and leaves at the bottom of the pond, find that the surface is still frozen over. The ice-covered pond may cause these frogs to die from lack of sufficient

Marsh frogs appear in early April, while some edible frogs may not emerge until mid-April or even early May; perhaps they require more sun and warmth to stimulate them because of their southern European origin. Toads and newts stay hidden until March or April. Natterjack toads do not emerge from their sandy burrows (where they escaped the frosts and freezing winds) until the weather is warm enough in March and April. Slow worms, adders and grass snakes start to flourish again in early March, while sand

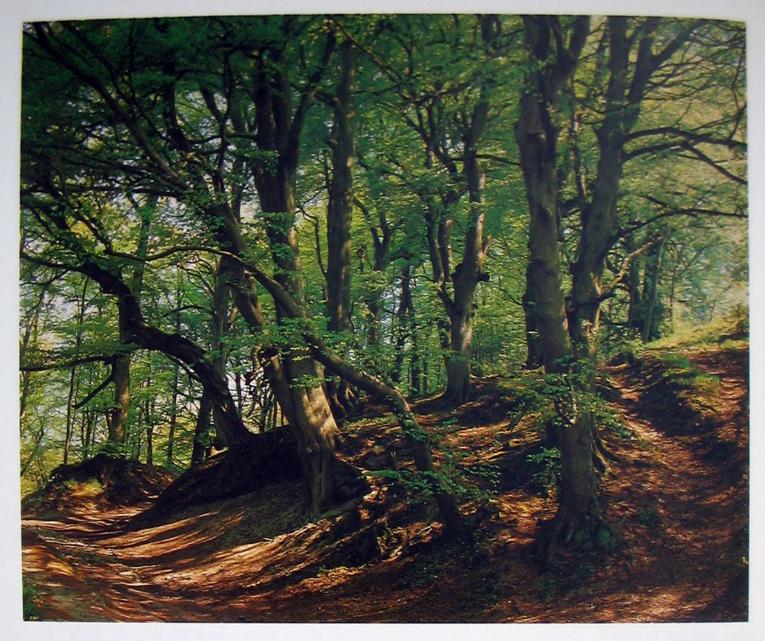


lizards and smooth snakes emerge a little

Shared slumber Reports of reptiles converging on the same spot to overwinter communally—entwined, in the case of snakes and slow worms—are not unknown. Adders are particularly sociable, often cohabiting in spectacular numbers; at Kirkcudbright, near Dumfries, a tangle of 40 was once unearthed, together with ten toads and some common lizards. Perhaps this strategy helps them conserve body warmth, or it may be simply a shared attraction to a highly favourable site. More surprising than the numbers is the fact that different sorts of reptiles and amphibians are discovered together.

This common frog has found some rotten wood to lie under for the winter. Frogs usually prefer to bury themselves in the muddy bottom of ponds.





BRITAIN'S WOODLANDS

Woodland in Britain has been more important to our civilisation and wildlife than its decline over the centuries would suggest; on its future rests the survival of many of our native creatures.

Broadleaved woods, whose leafy glades epitomize for many people the gentle countryside of lowland Britain, are the environment of many of our more interesting plants and animals.

Among mammals, the easiest to see are the several kinds of deer, which live in woods and come out to feed in the surrounding fields.

Squirrels make their home high in the branches. Dormice, now rare, feed and live in underwood and shrubs. If you wait quietly you may glimpse the wood mouse and yellownecked mouse, which sometimes forage for buds, nuts and insects high in the trees as well as on the ground. Other woodland mammals include common and pigmy shrews, bank vole, mole, hedgehog, weasel, stoat, fox and badger.

Woods are a rich habitat for birds. The common species, some of which also frequent gardens, are the robin, wren, blackbird, woodpigeon, chaffinch, chiffchaff, great and blue tits and willow warbler. Less often you may hear, or occasionally see, cuckoo, woodcock, nightingale, and three species of woodpecker.

Insects and other invertebrate animals are plentiful in many woods. The most colourful creatures are the butterflies, such as speckled wood, small tortoiseshell and silver-washed fritillary, which feed on sunny days on flowers in glades and at the woodland edge. Caterpillars, aphids and flies are the chief food of many of the birds. Dead leaves and rotten

As you walk through a peaceful copse or wood you probably have little idea of the intense activity going on all around you. Woods support a complex web of wildlife in which every plant and animal has its place, making as efficient use of the available resources as the best-designed factory. The fresh green leaves have just opened in this beechwood at Selborne Lythe in Hampshire, casting a dappled shade on the woodland floor.

wood are the home of beetles, woodlice, centipedes and millipedes.

Woods and human affairs After the last Ice Age, the British Isles was almost entirely covered by trees-the natural 'wildwood' until Neolithic men arrived in about 4000BC These earliest farmers began to get rid of the trees to make agricultural land. It is likely that by the late Roman period (AD400) farmland and moorland-both man-made habitats-dominated the English landscape. Ouite large areas of woodland remained; some of these were cleared in Anglo-Saxon and medieval times, and others were turned into managed woodland and some still exist.

Britain has for many centuries been one of the least wooded countries in Europe; but woodland, despite its limited area, has been most important to our civilization as well as our wildlife. Woods are, to some extent, wild places, in that their trees and other plants grow naturally and have not been put there; but all our natural woods, except those which have been formed very recently, have been managed, often for many centuries, to yield successive crops of produce.

Well over a thousand years ago, our ancestors decided to set aside some areas of the remaining wildwood as 'woodland', producing crops of timber and underwood, and to use other areas as 'wood-pasture', combining trees with grass on which domestic animals grazed. They also had 'non-woodland' trees in hedges and fields. These three traditions of tree management have remained separate ever since; you can still see woodpasture in Epping Forest and Richmond Park.

Much later (from the 17th century onwards) the custom grew up of growing trees in 'plantations'. This fourth tradition is the basis of modern forestry, which is quite separate from the management of woods. Woodmen use the trees that grow naturally; foresters 'plant' their trees-which nowadays are usually conifers—disregarding any native trees that may already be there.

Not all woods are ancient, nor have all woods that are not ancient been planted. Left alone, the natural tendency of almost any land in Britain is to become woodland. Open land is invaded by trees such as birch and oak which readily colonize new territory. 'Secondary' woodland, formed in this way on land which used to be farmland, moorland, industrial waste-heaps, railway verges etc., will not be the same as an ancient wood; it lacks species such as hornbeam and lime, which do not colonize easily, as well as many characteristic woodland plants.

Coppicing and pollarding When visiting a wood you should look for signs, particularly in the shape of the trees, that tell of the history of the wood and what it has been used for.

Trees with multiple stems are a sign of the commonest management practice, 'coppicing'. This uses the fact, well known to all

gardeners, that most broadleaved trees are not killed by being felled: the stump sends up shoots and becomes a 'stool' from which an indefinite succession of crops of poles can be cut at intervals of years. Aspen, cherry and most elms do not coppice; instead they send up shoots called 'suckers' from the root system.

Woods traditionally yield two products, timber and wood. 'Timber' is the large material suitable for planks, beams and gateposts; 'wood' is the smaller material suitable for light construction or firewood. A typical wood consists mainly of 'underwood' stools, felled every five to 25 years and allowed to grow again; among these stools is a scattering of 'standard' trees, grown to timber size. The standard trees are nearly always oak or ash, chosen for this purpose because of their value as timber. The underwood may also be oak or ash but is often of a wide range of other trees. A 'coppice' is a wood managed in this way; but the term is also applied by modern writers to the underwood itself, whether standing or felled.

A year or two after a coppice has been cut the ground vegetation flourishes and encourages a rich diversity of insects. Later on, the underwood forms a dense thicket which casts an intense shade and the vegetation declines; at this stage, however, the thicket provides cover for nesting birds such as the

whitethroat and blackcap.

An alternative to coppicing is 'pollarding'. The trees are cut like coppice stools to produce successive crops of wood, but at a height of 2-4.5m (6-15ft) above ground so that grazing animals cannot reach the young shoots. Pollarding is practised on woodpasture and hedgerow trees rather than those in woods.

In theory a coppice of 100 acres might contain 50,000 underwood stools and 2000 standard trees. Every year, the underwood on 10 acres would be felled, together with 20 of the 200 timber trees on those 10 acres. To replace the timber trees, 50 self-sown saplings or coppice poles of oak or ash would be left standing, in the expectation that 20 would eventually survive to reach timber size. In



Dead wood harbours life

Old trees have a special importance in woods as they support a particular range of animals and plants. Some species of lichen, for example, only grow on trees more than 300 years old. Different fungi colonize the dead wood, gradually decomposing it. Solitary bees and wasps nest in the crevices, while other insects hibernate in them. These insects attract birds such as woodpeckers, which nest in holes in standing dead trees. Later the holes are often taken over by other birds, dormice or hibernating bats. Certain beetles live only in dead wood. The larva of the largest British species, the stag beetle (above), depends on decaying wood for its survival. It lives and feeds on rotting wood for three years before emerging for its brief adult life. If dead trees are cleared away, as much as a fifth of all such woodland creatures could disappear.

Below: The hedgehog emerges at night for food. You can sometimes hear the crackling of leaves as the hedgehog roots in the litter for slugs and beetles.





Grey squirrels build their nests (dreys) high up in the tree tops; they are active during the day, leaping from branch to branch. This one has descended to the shrub layer to feed on hazel nuts.

this way the whole wood would be felled on a 'coppice cycle' of ten years and would continue to yield the same produce for ever. This is an illustration of what is rarely so simple or so regular in practice. Woods can vary in any proportion from all standard trees and no underwood to all underwood and no timber.

The character and continuity of a wood are maintained by the coppice stools, which (like pollards) live indefinitely. Timber trees come and go at the whims of owners, but the underwood remains.

In the past wood was usually more highly regarded than timber and it may yet be so again in the future; but over the last 150 years—a period of cheap fuel—such woodmanship as there has been tended towards timber rather than underwood production. Most woods, where they still exist, have been left standing for between 40 and 150 years, a much longer interval than would normally elapse between fellings.

Kinds of woodland It is traditional to describe woods in terms of the 'dominant' tree, the one or few species which, by their abundance or size determine the characteristics of that particular kind of woodland: for example ash woods, ash-hazel woods, ash-maple-hazel woods, lime woods. For this purpose the underwood is of more significance than the timber trees, which are a relatively arbitrary and impermanent feature. Although almost all woods contain a scattering of oak

trees, which are invariably treated as timber, this does not make every wood an oak wood.

Much of the variation in woods is natural and can be related to differences (which are often subtle) in soil or topography. Many woods are a complex patchwork or 'mosaic' of different kinds of woodland. In Suffolk and Essex, for instance, a wood of less than 10 acres may contain areas of ash-hazel, hornbeam, lime, cherry and elm.

Conservation Woodland is threatened chiefly by the extension of modern forestry, which turns wood into plantations, and agriculture, which destroys them altogether. In replanting a wood it is necessary to get rid of the indigenous trees and to prevent their regrowth from interfering with the planted trees. If successful—and the process is expensive and uncertain—the result destroys the character of a wood almost as completely as grubbing it out to make a field.

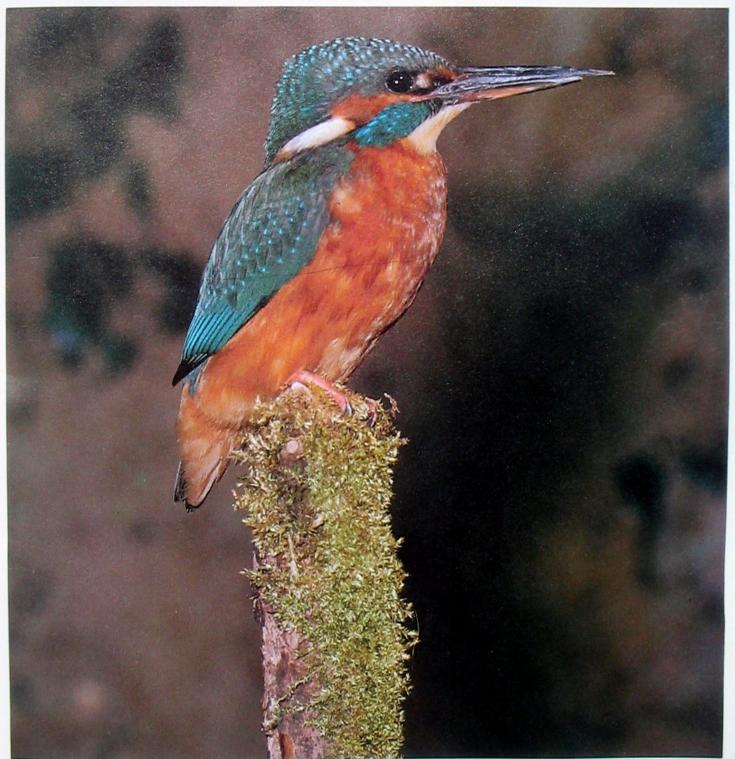
The destruction of secondary woodland can in theory be reversed, but once an ancient wood has been destroyed it is lost for ever. Between 1945 and 1975 at least a third of the ancient woodland area disappeared, a rate of destruction without precedent since the Norman Conquest. Since 1975 there has been less destruction, partly because there is less money to spend on it, but also because more people are coming to understand and appreciate woods and intend not merely to preserve them but restore them to their proper use.

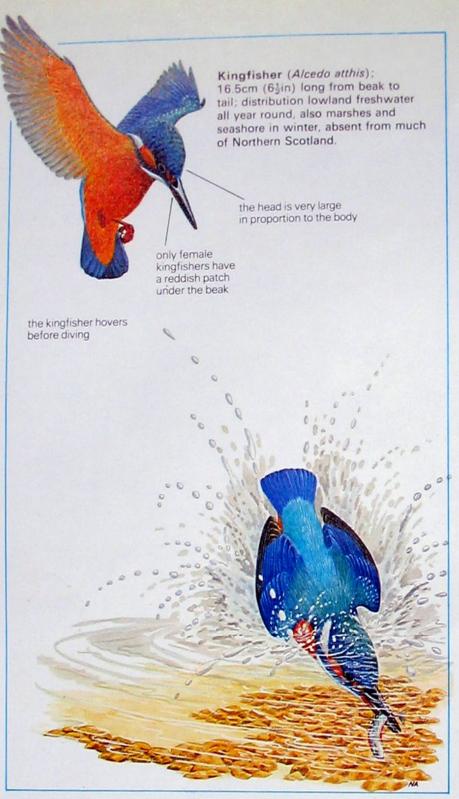
BRILLIANT WATERSIDE FISHER

Apart from its distinctive colouring, the kingfisher can be easily identified by its stumpy body, large head, short tail and long, daggershaped beak. Once these birds were persecuted for the crime of poaching hatchery fish, but now they are a fully protected species under the Protection of Birds Act.

The kingfisher is one of our most brilliantly coloured birds but its small size and rapid flight can make it difficult to spot. However, once seen it is seldom forgotten.

In flight the kingfisher looks like a flash of bright blue light as it skims fast and low over the water. It is one of Britain's most beautiful birds, with upper parts of an iridescent cobalt blue-or emerald green depending on the angle at which the light catches them-and a very noticeable paler blue streak stretching from nape to tail. The underparts and cheeks are a warm chestnut colour, which is most obvious when the bird is perching, and there's a patch of white on the throat and sides of the neck. And as if all this colour were not enough for one bird, the legs are a bright sealing-wax red. Juveniles generally have a duller plumage, shorter bills with a white tip and dark legs.





It would be surprising if such a colourful bird had escaped mention in myth and legend; the most attractive story comes from the ancient Greeks who said the bird—which they called 'halcyon'—bred in a floating nest at sea at the time of the winter solstice, calming high winds and stormy waves. Today 'halcyon' has come to mean any calm, peaceful and happy time.

Expert angler The place to spot the elusive kingfisher is near fresh, rather slow-flowing rivers, canals, lakes, ponds, streams, flooded gravel pits and even tiny streams in towns—almost wherever a ready supply of small fish such as minnows, bullheads and sticklebacks is to be had. These fish make up the bulk of

the kingfisher's diet; but it will eat insects such as caddis fly larvae and dragonflies, as well as tadpoles, small molluscs and crustaceans such as crayfish.

As its name implies, the kingfisher is an expert fisher. It normally perches on a post or branch over the water, watching intently for fish; if a suitable perch is not available, it hovers over the water. The instant a fish is spotted the kingfisher dives headlong straight into the water and grabs its prey with its open, dagger-like beak; the complete action, from leaving the perch to returning to it, is over in a matter of seconds. Minnows may be immediately swallowed head first, but spiny fish such as sticklebacks are beaten against the kingfisher's perch until they are dead and their spines flat enough for the bird to swallow them comfortably. You might see the kingfisher juggling the fish in its beak to get it the right way up to swallow. On average, adults catch a fish once every two or three dives, while juveniles only catch one every eight or ten dives until they gain expertise. In learning the art, some young birds drown because they dive too often and their feathers become waterlogged.

Pairing and nest-building Throughout autumn and much of the winter individual kingfishers keep to their own territory, male and female using separate areas of water; but in January or February the pair bond is established or renewed. The birds chase each other, often at considerable heights, in a swooping, diving aerobatic display, or they perch on a branch bobbing and bowing to each other. The attentive male will even fetch fish to feed to his partner.

From mid-February to mid-April you may hear the infrequent song of the kingfisher—a rapid, high-pitched succession of varied whistles. The bird's normal and very distinctive call is a loud, shrill 'chee' or 'chikee'.

As the weather warms up the pair look for a nesting site, usually in an exposed bank of a stream or lake. Once a suitable location is found they excavate a tunnel, which they start by flying at the bank and driving in their strong bills; they then build a chamber at the end of it. The tunnel, anything from 15-100cm (6-40in) long depending on how hard the soil is, slopes gently upwards. If a suitable waterside bank is not to be had, the kingfisher will nest among the roots of a fallen tree or in a sandpit, sometimes as much as 300m (330yd) from the nearest water. If you spot a kingfisher flying through woodland, the chances are it will be fetching food to take to an inland nest.

You can recognize the nest by the circular entrance hole to the tunnel, positioned near the top of the bank. Later in the season, disgorged fish offal round the opening will provide evidence of a nest, as will the dark slime trickling from the hole—the excrement of the young which is directed into the tunnel from the nest chamber.

Raising a family Kingfishers lay eggs at any time between the end of March and early July. Pairs can rear two broods a season and sometimes even three. Male and female share in incubation, when the clutch-usually seven eggs-is complete. At first the eggs are a translucent pink but they turn a shiny white colour during the 19-21 day incubation period. Both adults diligently feed the young which are blind and naked when they hatch. The young are fed a diet of tiny fish at first. After about 10 days their eyes open and the first signs of feathers appear; after two weeks they can manage much larger fish. To encourage their parents to keep them well supplied with food, the young keep up a continuous trilling or purring sound; the hungriest stand at the front of the chamber calling for food while the more contented sleep at the rear. The accumulation of fish bones and regurgitated pellets, as well as the youngsters' excrement, make such a mess of the tunnel and chamber that the adults have to take a quick bath every time they leave the

At the end of the breeding season the juveniles are chased out of the territory by their parents, who threaten them unmercifully and drive them out in noisy chases. Most go no more than six miles away, although some have been recorded as travelling up to 160 miles, mostly in the autumn, in search of fresh sources of food.



Hazards to survival Winter is an occupational hazard for all our resident birds and kingfishers are particularly vulnerable if the weather turns cold enough to freeze lakes and ponds and cut off the supply of fish. Many die of cold and starvation. Those lucky enough to find enough food to survive face an additional hazard-the alterations made by man to the watersides. Removal of trees used for perches, water pollution, the regrading of banks which destroys nesting sites and the levelling of streambeds which reduces the numbers of fish-all drastically affect the kingfisher's chances of survival. Fortunately, the kingfisher is still widespread over most of England, Wales and Ireland.

Above: Both male and female birds feed the young, who clamour incessantly for food; soon the nest chamber becomes littered with discarded fish bones.

Below: As part of the courtship ritual the male kingfisher offers his partner a fish. The female is the one with the reddish patch on the lower bill.



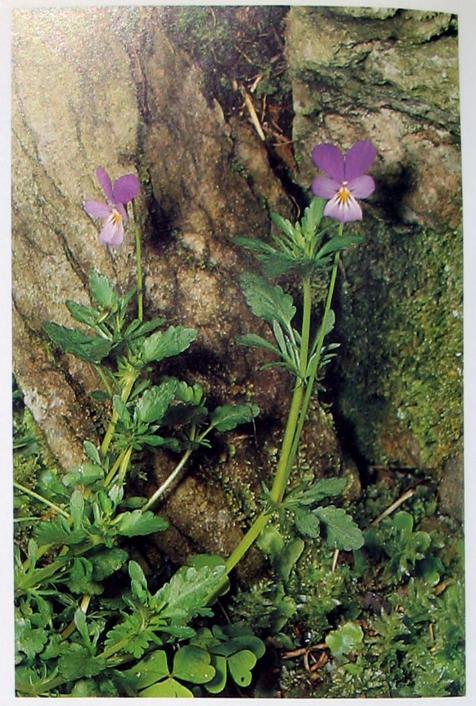
VIOLETS AND WILD PANSIES

From early March our hedgerows and woodlands are brightened by the lovely hues of violets and pansies; sadly only one violet, however, gives off a scent to match its beauty.

Thirteen species of violets and pansies are native to the British Isles and all belong to the family Violaceae. Both our common wild pansies are classed as weeds because they grow among crops, although you would be hard pressed to find two more attractive weeds

Violets all tend to be low-growing plants, often producing clumps of distinctly heart-shaped leaves and lance-shaped stipules which sprout from the root-stocks. Wild pansies tend to have more erect stems. Their leaves usually grow from the stem in groups of three and are variable in shape. The lower leaves tend to be rounded, whereas the upper leaves are more lance-shaped. The leaf stalks are often fringed with fine leaf-like stipules. (See illustration right.)

Similarities The flowers of violets and pansies have a similar structure: both consist of a pair of upper petals, a pair of side petals and one lower petal which extends backwards as a hollow tube (spur) in which nectar is secreted. The nectar is only available to insects, such as bees, moths and butterflies, with a tube-like tongue (proboscis) long enough to reach right into the spur. The lower petal and, to a lesser extent, the side petals are



Why plants have Latin names

The Swedish botanist Karl von Linné revolutionised the botanical world in the 18th century by devising a method of naming plants that was both simple and accurate. He gave each plant two Latin names. The first, written with a capital letter, showed the genius into which it and other closely related plants were grouped; the second was its species name, by which it was distinguished from its relatives. For instance, speedwells are placed in the genus *Veronica*. The grey speedwell's Latin name is *Veronica polita*, for its shining flowers look almost as if they have been polished. The ivy-leaved speedwell is *Veronica hederifolia*; the Latin word for ivy is *hedera*, so this literally means the speedwell with ivy foliage. In this way the species name usually gives you some extra information about the plant.

Many people find Latin names initially rather off-putting, but they can be less confusing than English plant names. The bluebell is a good example. In England the fragrant bluebell inhabits woodland: its Latin name is *Endymion non-scriptus*. But in Scotland the 'bluebell' is a scentless plant of heathland, a completely different species named

Campanula rotundifolia, which in England is known as the harebell.

Many Latin names reccur. For instance the Latin word for medical workshop, officinalis, often turns up in the names of plants used in medicine—Borago officinalis for borage, once used as an aphrodisiac, and Althaea officinalis for marshmallow, which was thought to cure many diseases. The word vulgaris, meaning common, is given to many widespread species, such as the primrose—Primula vulgaris. Names indicating the habitat of a plant also crop up frequently, such as nemerosa, meaning a woodland plant—as in Anemone nemerosa, the wood anemone—or arvensis meaning a field species—like Viola arvensis, the field pansy.

This system of classification makes it easier for scientists all over the world to communicate accurately exactly which species they are referring to. They are constantly reclassifying species in the light of new research, and the names they choose are words and parts of words borrowed from many languages which they then latinize. Karl von Linné even latinized his own name to Carolus Linnaeus.

Left: There are numerous references to violets and pansies in literature. In Shakespeare's A Midsummer Night's Dream Oberon squeezes the juice of wild pansies (seen here) on to the sleeping Titania's eyes so that she will fall in love with Bottom on awakening.

streaked with dark lines radiating from the nectar source. These 'honey guides' strongly reflect ultra-violet light which is easily recognised by bees—the most common pollinators.

The colour of the violets' petals varies enormously from deep purple to blue, mauve, pink and white; the spur is usually pale, often yellowish. The more rounded petals of the wild pansies are tinted with a mixture of white, yellow and mauve.

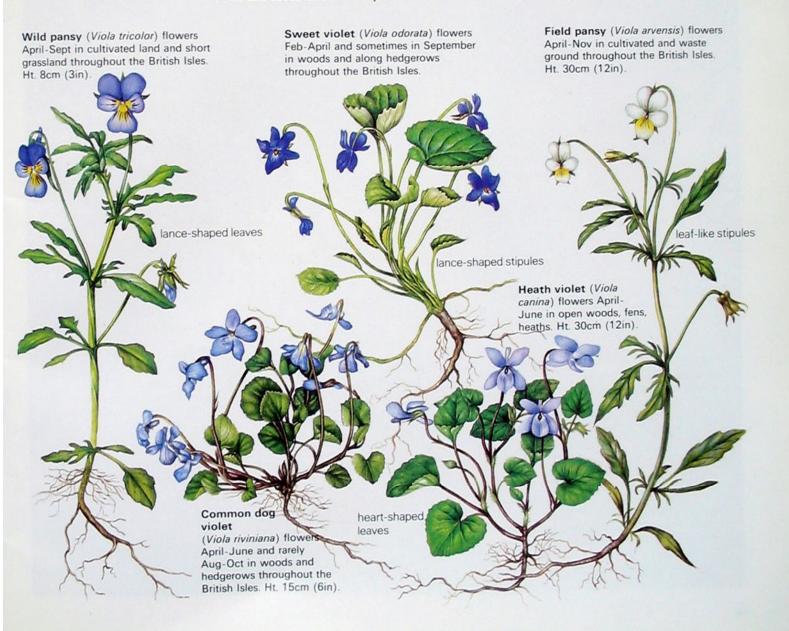
Reproduction An interesting feature of the violet family is that its members do not rely solely on insects for fertilisation. In a cold spring there are few insects around and, as the season progresses, violets tend to become submerged under the foliage of taller plants; so their flowers are hidden from view. Their reproductive chances are not lost, however: they grow a second cluster of flower buds in summer which never open. The pollen inside fertilises the flower which then produces good seed. This self-pollinating mechanism is called cleistogamy. The sweet violet can also reproduce a third way-by vegetative reproduction; it throws out long stolens that root at the tip when they touch the ground and make new plants.

Fruit and seeds The fruit capsules which lie

on the ground are divided into three boatshaped pods containing the seeds. As the pods ripen they dry and shrink, clamping tightly on to the seeds inside. When the tension becomes too great the pods split lengthwise and eject their contents. The system is effective: the tiny, almost weightless seeds of the field pansy have been thrown up to two metres from the parent plant.

The seeds of some violets are joined to a fleshy stalk rich in oils. Ants eagerly collect the seeds, carry them to their nests, and later discard them once they have eaten the fleshy stalks. This is why hairy violets flourish on grassy hillsides, where ant hills are often abundant.

The sweet violet may be the only scented British species of violet, but it is widely regarded as the most fragrantly perfumed of any native wildflower. In medieval times it was grown in gardens for use in both herbal medicine and cooking; the petals were added to meat and poultry dishes. The scent seems particularly quick to fade—and not just because it evaporates quickly. The reason lies with the chemicals that make up the scent; one constituent temporarily numbs the sense of smell of the person sniffing the flower.



THE MADNESS OF THE MARCH HARE

The brown hare is a highly excitable and eccentric animal which, particularly in spring, can behave quite strangely. There is in fact sound evidence to suggest a behavioural basis for the expression 'as mad as a March hare'—the courting instinct of the brown hare is responsible for much of its March madness.

The hare lives out in the open from the moment of birth. To keep warm it has a thick coat, which is white on the underside and a reddishbrown above, flecked with tawny gold, black and white to camouflage it. Like a rabbit it has a sensitive nose and a split or hare-lip.



Hares are not as a rule sociable; but they do shown an intense, if sporadic, interest in each other during the mating season. Groups of individuals, consisting of several males called jack-hares, will pursue a female (doe) in a chaotic, free-for-all display. During their dispute over the doe the jacks have boxing matches. They rise up on their hind legs, box and batter each other with their forepaws and turn in circles with their hind legs thumping the ground.

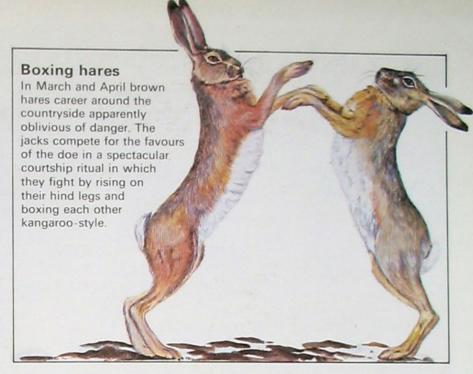
The display is reminiscent of kangaroos, which indulge in a similar fighting ritual. Neither hares nor kangaroos, however, kick with their hind legs which are extremely powerful and have long sharp claws that could inflict a fatal injury. In general the contestants box until one backs down, but jacks have been known to fight to the death. In one incident in the West Country, the victor broke its opponent's neck with a chop kick with its hind paw and then beat the body with its forepaws as if it were a drum.

Jack and doe may also have heated and vicious arguments. The jack will court a doe regardless of whether or not she is in season. If the jack is too persistent, however, the doe will box at him. As he makes his approach, the doe rises up on her hind legs and tries to keep head and shoulders above him; in this way she can box down at him to prevent any attempt he makes at mating. If that does not put him off, she will set upon the jack and bite him hard. He may well retaliate, and the fur will really fly until the jack backs off or the doe can make her escape.

Breeding behaviour The jack-hare is ready to mate before the doe—in early January, well before the traditional mad March—and continues through to September. He roams large areas of the countryside in search of a doe and, when he finally finds one, has quite a job persuading her to mate. Courtship technique is very much like that of a buck (male) rabbit; the jack pursues his female everywhere. He has to compete in a boxing match with others for the same doe; but even when he has won a doe he seldom stays with her for more than a day or two. This is, however, often long enough to ensure successful mating.

The jack then continues his roaming existence in search of more females. By contrast the doe has a more settled life. Preliminary studies have shown that she has a fixed home range-known in some counties as a muese-in which she rears her family. The first litter is usually born at the end of February and the last as late as mid-October. Litter sizes increase through the season, probably as a direct result of more food being available.

Birth The exact process of birth has always been a mystery. It was once believed that a hare gave birth to one leveret at a time each in a different form—the name given to a shallow depression usually in long grass, heather or rushes, which passes for the hare's nest.



However a recent film showed that the doe has all her young in one place and moves them to different forms, often some distance apart, after a few days. A Dutch zoologist, Dr. Broekhuizen, has discovered much about the next stages of a leveret's life from his studies on the brown hare in the Netherlands. In his early research, carried out mainly during daylight, he seldom observed the doe paying any attention to her offspring at all. Later he switched to night observation using spotlights, and discovered that about an hour after sunset the mother hare visited in turn each of her offspring hidden in its form.

The extent of the doe's maternal care is limited to one short suckling period lasting a maximum of three minutes per visit. Perhaps the most interesting behaviour revealed by this research was that a doe may suckle young other than her own. This happens when the leverets are two or three weeks old and beginning to be more adventurous. Quite often two or three gang up together from different families in the neighbourhood. But as long as one leveret in the group is hers, a mother will not begrudge feeding both her own and those of her neighbour.

Chances of survival From the moment of



The hare's large eyes have a very glassy quality which enhances the idea that there is madness in the stare. The eyes are on the side of the head and so give good widefield vision; they can also look backwards. Sometimes, when being chased, the hare will run straight into a net or other object, since it suffers from a blind spot immediately in front.



At first glance it is easy to mistake a hare for a rabbit, particularly at a distance. The best way to tell the difference is by the hare's longer, black-tipped ears, and longer, more muscular hind legs. Both hares and rabbits have a split lip, or hare-lip, although there are slight differences. A rabbit's top lip is split up to the nostrils, but has a layer of skin (membrane) to cover the gums. A hare's top lip is split so that the gums are visible. As a result, the top 'buck' teeth may protrude, particularly in old age.

birth, hares live out in the open. For the first weeks of their life, the leverets' instinct is to lie completely still in their 'milking forms'. Like most mammals born in the open, leverets have a coat of fur and are soon fully mobile. This is in complete contrast to rabbits, which are born naked, blind and helpless in the security of a burrow. Leverets have no such security and have to be fully prepared for life in the open.

They soon start to move about to feed and at this stage may fall victim to foxes, stoats and buzzards. Rabbits also are said to kill leverets by biting them on the back of the head. This may be an old wives' tale; but as buck rabbits often kill young rabbits in their warren, they might do the same to young leverets if they came across them. Something like 50% of leverets die before they are a month old, because of predators and the effects of exposure. Does have several litters a year to compensate for this rate of mortality.

To escape from predators the adult hare relies on its highly sensitive hearing to pick up the sound of any approaching danger a long way off. Keeping a sharp watch it will then run away as fast as possible if danger threatens. A rabbit, however, does not detect predators until they are much nearer—and doesn't need to because its burrow is usually only a short dash away. Since the hare's hind legs are much longer and more muscular than those of a rabbit they can power a hare to

35 miles per hour and enable it to jump a height of 2m (6½ft). The hare tends to move in a leapfrog motion with its hind legs landing in front of its forelegs. This is particularly pronounced at speed, when the stride may be as much as 4.5m (15ft). The hare's heart is very strong (much stronger than a rabbit's) and this certainly contributes to its phenomenal stamina. A hare can run up to four miles without tiring; it can also swim if it has to.

Tracks and signs The hare's tracks are easily recognisable by the long prints made by the hind legs and the smaller, rounded foreleg prints. The larger size of these tracks distinguishes them from a rabbit's. If the prints are fresh and clear, you can see four toe prints on the forepaws and four on the hind paws. Dropping are also a familiar sign and are similar to, but larger than, a rabbit's. In some cases they are more fibrous and paler.

The hare is usually a silent animal, although you may hear one emit a scream like that of a child in terror: this cry is given by a leveret in distress, and will immediately bring any doe with leverets running to the scene. An adult hare in pain makes a similar cry.

Night assemblies In areas like Norfolk and Cambridgeshire hares are particularly abundant, and some East Anglian farmers have reported large gatherings of hares—hare parliaments—at night; up to 20 hares have been seen sitting motionless in a circle under the moonlight. In one case, two hares moved

BROWN HARE (Lepus capensis). Also known as common hare

Weight of male (jack or buck) averages 3.6kg (8lb), 5kg (11lb) max. Female (doe or jill) slightly more Length (nose to tail) 55cm (22in)

Colour basically brown, flecked with tawny, yellow gold, generally white underneath

Breeding season early Jan to September

Gestation 42-44 days
No of young (leverets) 3-5
Lifespan average 2½ years,
exceptionally 12-13 years
Food diet of grass and
cereal crops, mushrooms and
shoots; re-ingests droppings
Predators farmers, foxes,
stoats, birds of prey
Distribution farmland in
Britain and Northern Ireland.
Occasionally among sand
dunes and woodland

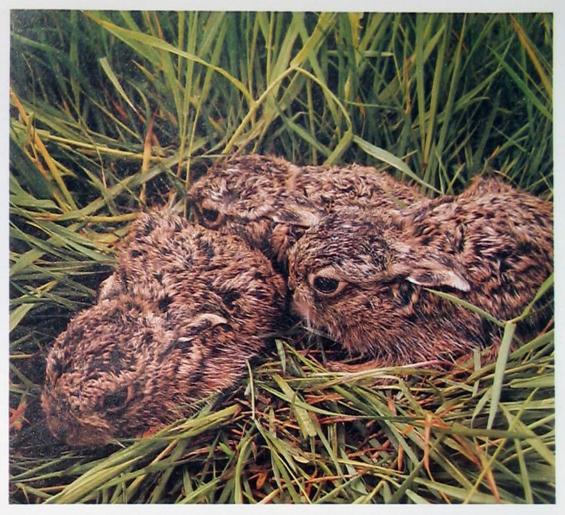


usually only four of the hare's five toes show on the track



Left: Hares move across the ground in a leapfrog motion, which is particularly noticeable when they are travelling at speed.

Hidden in their form, a shallow depression in long grass, these three leverets lie absolutely still; being born in the open they have little choice if they are to escape the notice of foxes, domestic cats, or birds of prey flying overhead.



to the centre of the ring and boxed each other in front of the members of the parliament. The significance of this is not fully understood, but it does support the theory that hares are essentially nocturnal animals, particularly during the mating season (when these parliaments take place).

Hares certainly feed a lot at night, when they are in less danger of being shot by man. You can see hares out feeding in the fields at night if there is a full moon, which for many people explains the hare's madness. According to folklore anyone who stays out under a full moon will go mad (the word lunatic comes from the latin word *luna*, meaning moon); hence the hare must be mad. It has been pointed out that if you turn the moon upside down in your imagination, the 'man in the moon' becomes a hare.

'Hareports' Perhaps the hares' most extraordinary behaviour has been seen at airports. Several times over the last decade, large numbers of hares have been reported at Heathrow and Gatwick airports, living on the grass alongside the runways; there are similar reports from airports all over Europe. It seems totally out of character that animals with very sensitive hearing could live in such an ear-shattering environment; but the strange thing is that the hares actually seem to enjoy it. When the planes land and take off, the hares often race alongside as if trying to outstrip them. This reckless behaviour is in



line with the reputation brown hares have and it is hardly surprising therefore that such expressions as 'hare-brained' have come into being and are popularly used.

Although we now partially understand the brown hare's strange spring behaviour, there is still much that remains steeped in folklore. For instance there is an ancient belief in parts of Wales that the hare changes sex every month. Certainly distinguishing the two sexes is often difficult, but the best way to tell them apart is by watching the mating ritual—when they go 'hopping mad'. Perhaps it is not so surprising to learn that the word hare derives from the Anglo-Saxon 'hara' which means to jump.

The hare digs a narrow resting hollow or form, which it lies in during the day. The form is dug out slightly more at one end than the other—the deeper end accommodates the hare's large and powerful hind quarters. The form is usually orientated so that the hare can sit with its back against the wind.



WHEN'S AN INSECT NOT AN INSECT?

Although there are more than 21,000 known species of insect in the British Isles, there are many more 'creepy crawlies' which aren't insects at all. So how can you tell the difference?

Creatures such as ants, bees, butterflies, lice, spiders and mites are invertebrates—ie they have no backbones. They are also arthropods—with segmented bodies, jointed legs and hard outer skins. These three characteristics separate the arthropods from other invertebrates such as earthworms, slugs, snails or jellyfish. There are 12 different

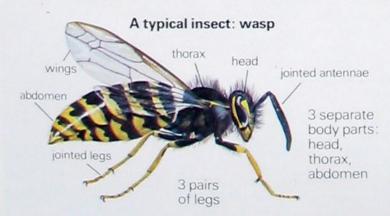
groups of arthropod which together make up a staggering 85% of the world's animals. All insects are arthropods, but not all arthropods are insects. Some of the best known noninsect arthropods are spiders and mites, centipedes and millipedes, and crustaceans such as lobsters and woodlice.

The hard, horny outer skin is one of the main reasons for the success of arthropods. It stops loss of moisture through evaporation and it protects the animals from damage and bacterial invasion. It also limits size; if the animal became too big the weight of the outer skin would be too great for the muscles to support. And, of course, since the skin is hard and rigid, it limits growth. An arthropod has to undergo a special moulting process in order to grow. With most insects, such as butterflies, ants and bees, this takes place when the animal is still immature; the adult insect does not grow (except for some simple ones like silverfish and springtails which continue moulting until they die). Most other arthropods carry on moulting throughout their lives.

In order to moult, the arthropod splits its

The wings on this common wasp (Vespula vulgaris) immediately identify it as an insect. Other features to look for which will aid identification are the three pairs of legs and the three clearly separated body parts.

How to tell an insect from other arthropods



Arthropods which are not insects:



skin, sheds it and emerges in a new coat; it swallows air to expand the soft new skin before the skin dries and hardens, and can thus increase in size.

Recognising an insect The easiest way to learn how to recognise an insect is by looking first at the adult, since the complex life cycle of the more advanced insects involves several stages in which the young may look completely different from the adult.

There are three main identifying features to look for. The easiest to check is whether the animal in question has wings. If it has wings (one or two pairs), it is an insect; all invertebrates with wings are insects. However, not all insects are winged, so look next for legs. Practically all adult insects have three pairs of legs-never more and seldom less. The third thing to look for is body parts. All insects have three quite separate body parts-head, thorax and abdomen. The head carries one pair of antennae (or feelers), compound and/ or simple eyes and mouthparts; the thorax carries three pairs of legs and one or two pairs of wings (although certain insects, like some forms of aphids, have lost their wings); the abdomen carries the sex organs. One insect, which carries all these parts, is the wasp; a worker ant has all these parts except wings.

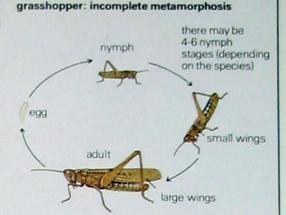
Recognising other arthropods None of the other arthropods has wings, so look first at number of legs. Spiders, centipedes, millipedes and crustaceans all have more than three pairs of legs. Spiders have four pairs, while millipedes have dozens. Also, these arthropods have only two separate body parts -the abdomen and the cephalothorax (head and thorax fused together). In addition, spiders do not have antennae, although centipedes, millipedes and crustaceans do. In fact, for all practical purposes, the legs clinch it; three pairs of legs mean it's an insect, and more than three mean it isn't. Don't be confused by caterpillars which look as though they have more than three pairs of legs. The 'legs', known as prolegs or pseudopodia (false legs), on the abdominal segments are fleshy projections which have a ring of minute hooks on the end that enable the caterpillar to cling firmly on to its support.

The complex life cycle of insects

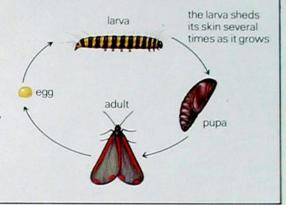
Metamorphosis (ie change of form) occurs in two ways, incomplete and complete.

Incomplete Eggs of less advanced insects such as grasshoppers and dragonflies hatch into 'nymphs', looking like miniature adults but without wings. Wings are developed gradually over successive moults. Complete Eggs of more advanced insects such as beetles, flies, wasps, moths and butterflies hatch into larvae (called caterpillars in the case of moths and butterflies) which look nothing like the adult. The larvae usually feed voraciously, moult several times and at the last moult emerge as pupae (or chrysalids). During this resting stage larvae change dramatically into adults. When the insects are ready they split open the pupa case and emerge as winged

adults.



moth: complete metamorphosis



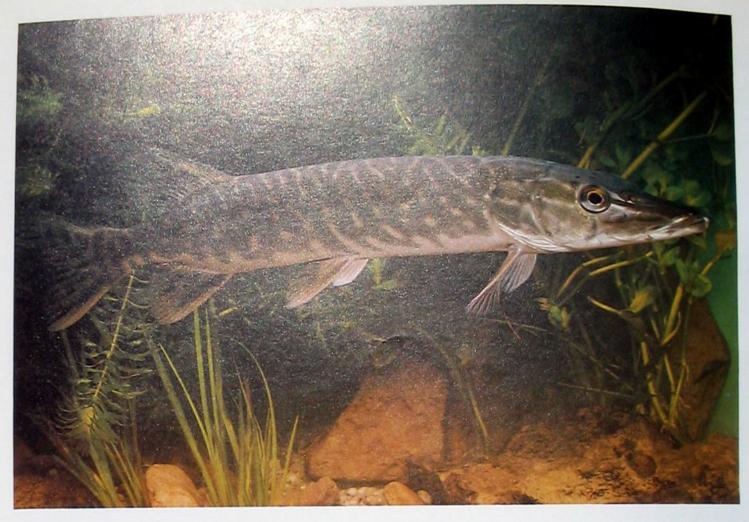
Nature's success story Insects are the most successful group of animals ever. There are nearly a million known species in the world, over 21,000 of which live in the British Isles. The reasons for their success are not difficult to find-their hard, protective outer skins; their ability to reproduce in huge numbers; the capacity of many species for flight; and the adaptability of their complex life cycle (which means different forms of the same insect can utilize different feeding niches)-all stack up the odds in favour of insect survival. So, superbly equipped, the insects can exploit almost every habitable corner of land, water and air, and eat pretty well every kind of plant and animal food.





3 body parts which are not clearly divided no wings

many pairs of legs Because of their small size, insects and other arthropods can be very difficult to identify. Close observation will help you familiarize yourself with the huge variety of shapes and colours that occur; watching for details of where these creatures are found, how they move and what they eat will provide valuable extra information.



THE PIKE: HUNTER OR HUNTED?

Few fish have been the subject of taller stories than the pike, our largest native freshwater fish. Exaggerations are also made about the threat of the pike to other water inhabitants.

One of the tallest pike tales comes from Germany and involves the 'Emperor's pike', which was said to have lived for 267 years after the Emperor Frederick II released it into a lake at Lautern in 1230. A fish skeleton of great size, kept in the nearby Mannheim cathedral, was reputedly that of the 'Emperor's pike'. In fact it was later found to have been 'stretched' by the amalgamation of the backbones of two large fish.

Monster pike have been recorded in Britain but often the details are unverified. The 'Kenmure pike' caught around 1774 in Loch Ken in Kirkcudbright weighed 32.62kg (72lb) according to one contemporary author; another says 27.63kg (61lb). When the bones in

its head were compared with another fish from the same loch, they were found to be the same size; the other fish weighed only 17.67kg (39lb). There is no doubt however, that pike in British waters can weigh in excess of 22.65kg (50lb).

The head bones of the 'Lough Conn pike' caught in 1920 and weighing 24.35kg (53lb 12oz) are still preserved in the Natural History Museum in London, although they are no longer on show.

Scarcer and smaller All these large fish were caught many years ago and it is possible that over the last 30 years or so conditions in many of our waters have become less favourable for the pike. More anglers fish for them and, although many anglers do take the trouble to return them safely to the water, some losses must occur. Fishery management practices often call for the removal or decrease in the numbers of pike, as they are predators of other fishes. Pollution has also probably affected the pike as much as any other fish. As a result of all these pressures large pike seem to be much scarcer than they were even half a century ago.

The situation is made worse by the fact that the pike is not a very long-lived fish. It is possible to find out how old a pike is by examining the growth zones of its gill cover (much as one can find the age of other fish from their scales or the age of a tree by counting the rings on its trunk). Study of the

The pike's unmistakeable torpedo shape, colour camouflage and large jaws make it a deadly hunter. It can often be seen on sunny days lurking in shallow water among dead vegetation, as shown here.

pike in Lake Windermere has shown that it is quite exceptional for these fish to live much longer than 15 years and 18 years was the maximum age recorded in a very large sample.

Where it is possible to be certain of the sex of the fish it has also been found that all the largest pike have been females. Out of a total of 7000 fish taken from Lake Windermere for research into pike, the largest male weighed 5.76kg (12lb 8oz)—the largest female was 16.92kg (35lb).

The size that pike attain and their rate of growth vary very much with the availability of food. Some of the best pike waters are the large lakes where water high in dissolved minerals and rich in nutrients provides a good food supply. Thus growth is remarkably fast; Loch Lomond in Scotland also contains very large pike which have grown relatively fast. The underlying reason is abundant food. The Irish loughs contain large numbers of trout, and other fish such as rudd and bream, while Loch Lomond has powan and other species which provide plentiful nourishment.

Voracious feeder The pike is a predator all its life and because of its size there are few fish in our fresh water which it will not feed on. When first hatched, however, it takes mainly small invertebrates, later graduating to insect larvae and small crustaceans like water fleas. At the end of its first year of life it has grown sufficiently to enable it to take young fish, although it will still eat substantial numbers of aquatic insect larvae. Most of its food consists of fish which are active swimmers, especially shoaling fish such as roach, minnow, dace, perch and trout, but it also eats numbers of sticklebacks if available.

Large pike extend their diet beyond fish and are known to eat ducklings and occasionally fully-grown mallard. Other swimming water birds have been found in their stomachs, as have water voles and brown rats. There have also been reports of attacks on dogs; an alsatian swimming in the River Lea near London, was seized by the tail. Pike do not, however, attack man although many an angler has suffered bites when unhooking a captured specimen; large, live pike have to

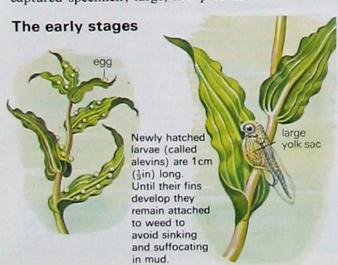


be handled with respect to prevent accidents.

Stealthy hunter The pike relies on stealth to capture its prey. It lies up in vegetation where its dappled colouring keeps it well camouflaged, and waits for fish to pass close by. Then, propelled by the huge paddle-like tail end (all its propelling fins are at the end of its body), it makes a lightning charge at its prey. Mostly it hunts by sight; it has a groove, rather like a gunsight, on the snout in front of each eye which helps its forward vision. As a result most of its feeding is done during daylight hours. It has a moderately good sense of smell and can detect an angler's dead bait at night, although finding food by scent is not its prime method of feeding.

Pike prejudice Because the pike is a predator, there is at times prejudice against it on the grounds that it eats too many fish and birds. While there is certainly no place for a pike in a trout farmer's ponds, in most natural waters the pike has a positive role. Simply because pike are fish-eating predators they are always scarcer than their prey and it is estimated that even a lake the size of Windermere can contain no more than 4600 adult fish. In fact we rely on predators to keep in check the number of other species; otherwide the water would become overrun with small, stunted fish. For these reasons there is no justification for killing pike or indeed for controlling their numbers except in unnatural situations.

The pike's fierce looking mouth has a set of needle-sharp teeth in the upper jaw which point backwards to prevent prey escaping. The pike is adapted to make a powerful seizing lunge and will tackle fish almost its own size, as well as frogs, voles and water birds.



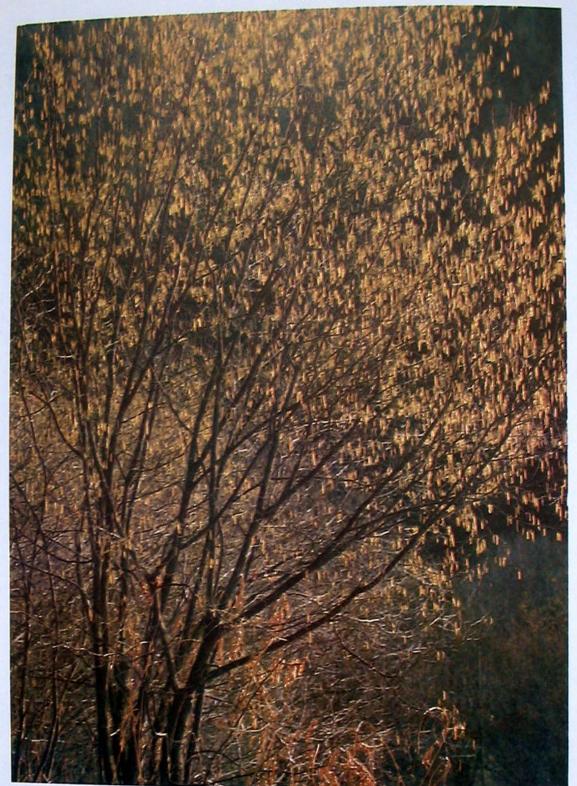
Over 3-4 weeks between late March and early May a female pike may shed up to half a million sticky eggs. Each egg is 3mm (‡in) across.



For the next 10 days larvae remain attached to leaves by an organ on the front of their head, while fins and mouth develop further. 10-day-old alevin are 13mm (½in) long. The yolk sac is very reduced but the mouth is now fully formed.

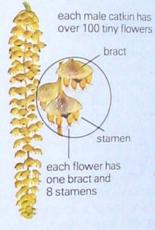


At 3cm (1¼n) long the young pike resembles the adult: it swims freely and feeds on live food.



The hazel tree in early spring: the male catkins—lambs' tails—dangle from leafless twigs and release clouds of dusty golden pollen.

Looking closely at a hazel catkin



The stamens will ripen when the temperature is over 0°C. The ripe stamens split open lengthways to release their yellow pollen.

THE VIGOROUS HAZEL

The hazel may be one of our smallest native trees, but it has had an important role to play in the history of woodland management. Apart from its value as wood, it also has—according to Celtic folklore—magical properties.

The hazel grows as a small native tree in the shade of woods and in hedgerows. In old neglected coppices it throws straggling limbs from old stools and is rarely able to form the single trunk to give it the status of a tree.

Yet it is an important tree. In the fossilized pollen records preserved in peat which are our guide to the earliest native plants after the Ice Age, hazel predominates over much of the British Isles—appearing at much the same time as the initial spread of other wind-pollinated trees such as alder, willow and birch. Remains of hazel nut shells have been found at the foot of peat deposits, suggesting that the early Stone Age hunters were probably at least partly dependent on the nuts for

food, in the absence of any sort of cereal.

Since hazel is associated with man's earliest ancestors, it is perhaps not surprising that in Celtic folkore it was known as the tree of knowledge, and was supposed to have many magic properties. Irish aches and pains caused by the damp climate or elfin malevolence were thought to be warded off by a hazel nut carried in the pocket. A double hazel nut was said to cure toothache in Devon, and defend against witches in Scotland. Hazel is one of the magic trees of May Day, like hawthorn in England and rowan in Scotland: these are the three trees of white magic that oppose the forces of evil which many people thought were present in the woods.

In 1956 there were more than 16,000 acres of hazel coppice, little of which was used. Since then the coppiced areas have dwindled as foresters have gradually turned them over to conifer production. For truly wild hazel trees you must go to the Lake District, the Western Highlands or the Burren in County Clare, Ireland. You can see coppiced hazel in Hatfield Forest, the Sussex Weald and on the Wiltshire downs.

The hazel belongs to the same family as the hornbeam, which has more scaly catkins and winged nutlets. The hazel leaf is a dense, deep green colour which turns to brown then yellow-gold towards the end of the year. Hazel bark is shiny, brownish grey with horizontal pores (lenticels) which enable the tree to breathe.

Catkins and flowers The brownish-yellow male catkins begin to develop in autumn; early the following spring they open to a creamy yellow colour. The female catkins are small and brown with bright crimson styles and they generally ripen after the male catkins of the same tree, a mechanism which usually prevents self-pollination. Like all catkin-bearing trees, the hazel is wind-pollinated.

Nuts There are between one and four, and occasionally five, hard-shelled nuts on each stalk. They are pale green in summer, but by autumn have turned to a warm, soft brown colour. Each nut is enclosed in a pair of downy husks or bracts with deep scallops. Many children's fairy stories show pixies wearing hats of a similar style.

Birds, especially pigeons and pheasants, and small mammals such as squirrels and mice, take the nuts for food and bury them. This is one way the trees become dispersed. You can grow the hazel in your garden either from a seed or from a sapling. For your own trees to produce nuts you will need at least two trees to ensure cross-pollination because the species is naturally self-sterile (ie the tree cannot fertilise itself). A hazel tree produces nuts in abundance from six years old. There are several varieties available, including *Pendula* which makes a standard tree with a trunk of at least 1.5m (5ft).

Selective breeding of the hazel in the 19th century produced the large Kentish cob nut which is redder and rounder than the wild nut. The more oval filbert nuts come from a different species, Corylus maxima. It is thought they originated in France and were named after Saint Philbert.

Today many English nuts in shops come from the Kentish nut plantations, although we import thousands of tons from the Mediterranean for use in confectionary. Richard Mabey in Food for Free recommends using the nuts in salads, chopped or grated, in muesli, blended into a milk drink, or as nut cutlets. Weight for weight, he says, hazel nuts have half as much protein as eggs, seven times more oil and fat and five times more carbohydrate.

Management The management of hazel woods dates back to the late Stone Age. The tough straight poles produced by coppicing the tree are still used today in fencing and as bean and pea sticks and small stakes. The rod used by a diviner to detect the source of water is often made of hazel.

In the days of open field farming, split green hazel poles were woven into hurdles to fence in pigs, cattle and sheep to stop them eating the crops on adjoining land. The tree also produced the wattles for wattle-and-daub building as well as the spurs used in thatching. The brushwood was bundled into faggots that were used for the weekly firing of bread ovens.



Sept-Oct.

Hazel (Corylus avellana),

of years if coppiced

regularly. Common

deciduous, native, grows to

throughout the British Isles.

Flowers Jan-April; cob-nuts

6m (20ft). May live hundreds

At least two hazel trees growing close together are needed for fertilisation and the production of nuts. This is because the female catkin usually ripens after the male flower of the same tree.

Hazel nuts are rich in oil and the oil from a single nut rubbed over the surface of a stout hazel walking stick will give it a good polish.



Coppicing

A copse is a small wood. A coppice, however, is a special sort of woodland, and coppicing the earliest known form of woodland management. It is a method of cutting broadleaved trees down to the ground at regular intervals—anything from five to 25 years, depending on the species. A cluster of new shoots sprout up from the stump (stool) and these eventually provide new, manageable straight poles.

The word coppice comes from the French couper to cut, but coppices were managed long before the French came to England. Trackways across the marshy areas of Somerset were built of poles which have been identified as coppiced alder, ash, holly and hazel dating from 2500BC. By the 15th century large areas of southern England were coppiced. In the 16th century coppice-with-standards was common: standard trees—often oak or ash—were allowed to grow to maturity above the coppiced trees to increase the national timber reserves for the construction of buildings and ships.

Strict rotation in cutting and enclosure by a deep ditch or strong fence to prevent grazing animals from eating the tender shoots have always been essential in coppicing. A hurdle maker might spend a year working two acres, so a coppice of 14 acres would keep him and his billhook perpetually employed. Old coppices often retain the name of a man who worked there, perhaps for a life time, such as Emblems Coppice and Collins Coppice in Hatfield Forest.

Today coppiced wood is once again becoming valuable as firewood in rural areas; among the other values of these woods, hazel is used for hurdles (see below), sweet chestnut for fencing, ash for tool handles and willow for basket-making. Many old coppices have become overgrown through neglect, but coppice-withstandards is still practised in a small way, and is encouraged by conservationists. Not only does coppiced woodland provide a number of different woods, but it is a haven for a huge variety of wildlife with its ever-changing layers: the ground of a freshly cut coppice is covered with wild flowers; the re-growing trees offer nesting places to numerous birds; and the mature coppice shelters yet more animals and carpets of bluebells.





Left: The base of a much coppiced hazel tree with dog's mercury and moss growing in the centre of the stool. Regular coppicing greatly prolongs the life of a tree.

Below: A hazel tree growing among standard oak trees. The hazel might be coppiced a dozen times before the mature oak is felled.



FERTILE FLOOD MEADOWS THEN AND NOW

Along some of our lowland rivers lie flat meadows-known as flood meadows-which are prone to regular winter flooding. Invertebrates in the mud and floating grass seeds attract flocks of ducks and geese in winter; later, breeding birds feed on insects and butterflies gorge on nectar from the meadow flowers.

This riverside meadow, rich with knapweed, creeping buttercup and grasses such as crested dog's-tail and reed sweet-grass, is part of a 275-acre flood meadow area of West Sedgemoor in Somerset which was recently saved by the Royal Society for the Protection of Birds from the threat of drainage. It is flooded annually by the River Parrett.



Lush green meadows in river plains, detted with pale pink cuckoo flower, perfumed meadowsweet, white sneezewort and tall clumps of rushes and sedges, form some of the last surviving 'unimproved' grasslands in the country. They have not yet been drained or reseeded or treated with artificial fertilisers or herbicides. They are ancient meadows where once-common plants, insects and birds can still be found.

In recent years many of our river valleys have been extensively drained to prevent winter flooding. The adjacent fields are then converted to perhaps more profitable arable farming at the expense of this natural wetland habitat. However, there are still stretches of some rivers which flood each winter; these include the Hampshire Avon at Ibsley, the Parrett and Axe in Somerset and the Ouse in Yorkshire. There are also smaller areas of land (sometimes just a few fields) which are under water for varying periods each year: some may not flood for very long, others may not do so in very dry years. But in the richest of such meadows there may be up to 60 species of flowering plants, 15 grasses and a similar number of rushes and sedges.

These ancient meadows, undisturbed by ploughing, are distinguished by the diversity of their plant life. Marshland plants such as the bright yellow marsh-marigolds and the blue water forget-me-nots adorn the ditches while patches of great burnet and meadow-rue



grow among the lush grass. The nutrient-laden silt deposited by the winter floods provides a natural fertilizer. If the meadows were left untended through the summer the stronger grasses such as fescues and tufted hair-grass would gradually oust the majority of the flowers. However, grazing by cattle and sheep keeps the grass down and enables a much greater variety of plants to survive. In the summer you might see hares and water voles, but if animals remained for the winter they would drown as the meadows flooded.

Plant feeders The abundance of plant life provides food for many kinds of animals from geese in winter to myriads of insects in summer. The permanent nature of the grassland Snipe, like many other waders, hollow out their nests in tussocks of grass where they sit tight until you practically walk on them. Then they explode into the air with great speed. They feed at night, probing in the mud with their long beaks for worms and insect larvae.





Above: Clusters of golden marsh-marigold appear in spring, attracting large numbers of insects. They thrive on wet nutrient-rich ground, and continue to flower until July.

Below: For 19 miles along the River Ouse on the Cambridgeshire-Norfolk border the riverside meadows, known as washes, are deliberately flooded for two or three months during the winter. They attract several thousand mallard, teal, and pintail every year.



is also crucial to this diversity, in that the animals of the soil such as mites, worms and insect larvae are able to survive without disturbance by cultivation or the use of pesticides. Various butterflies, moths, beetles, flies, bees and wasps feed on plant partsroots, stems, leaves, seeds, flowers, buds of grasses, rushes, sedges etc.

Many insects depend on a particular plant at various stages in their life cycles. For example the caterpillar of the marbled white butterfly feeds mainly on cock's-foot grass and the adult is able to collect nectar from many of the flowers. Worms are often especially numerous and the waterlogging of the soil forces them—and also insect larvae—to remain near the soil surface to escape drowning. Here they are easily accessible to birds and hence the attractiveness of flood meadows to large numbers of waders, which can easily probe the soft mud to exploit the abundant supply of food.

Wildfowl invasion When the winter floods swell the rivers, filling the meadows with water, flocks of mallard, teal, pintail and other wildfowl move in.

As the floods rise so large numbers of insects are flushed out of the grasses and drown. Quantities of seeds from the flowering plants fall into the water and drift to the edges of the flood. Both insects and seeds are eaten by the ducks. When the water level is low enough flocks of waders such as lapwings and golden plover feed on the insects, probing for them in the mat of grass roots.

Soft mud conditions must last throughout the early summer if meadow birds such as snipe, curlew and redshank are to breed successfully. Parent birds need to be able to extract animal food from the soil from March until May; and then the young birds must be able to feed themselves until they are old enough to fly off in June.

Man's involvement The management of the meadows is also crucial to birds in their search for food: tightly packed tall grasses and flowers cannot be easily penetrated by probing waders. Before the meadow is cut for hay, the birds have to move out to the field edges or nearby arable land to feed. But

The marbled white butterfly

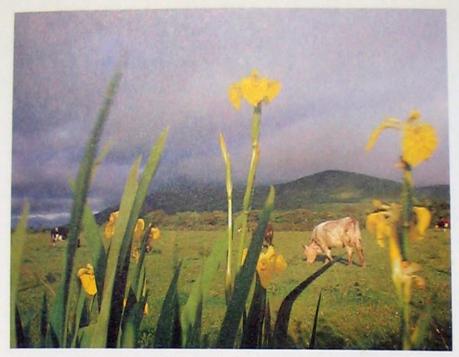
The rich variety of plants growing in the flood meadow in summer support a mass of insects which take advantage of the bounty of root, stem, leaf and flower. One of the most attractive, the marbled white butterfly (Melanargia galathea), is about in high summer from the beginning of July to mid-August. The adult feeds on the flowers of such plants as knapweed and thistle. As they are not strong fliers you might see several resting together on the flowers, wings spread wide open in the sunshine. The female is usually larger than the male and has rounder wings. A pair are shown here mating. The female scatters her eggs in flight so they land at random on a variety of plants, but the pale, straw-coloured caterpillars which hatch out and go into hibernation almost at once will not survive the winter flooding of the meadow. The marbled white butterfly will only breed successfully in areas of chalk downlands and grassy meadows and roadsides.

The marbled white butterfly belongs to the Satyridae family (which is often known simply as 'the browns') but it is an odd one out since it is coloured white with dark markings. Like other members of its family it walks on four legs only; the front pair are useless and much reduced in size.



once it is cut they can get at the soil again. The traditional rotational method of haycutting in some years followed by cattle and
sheep grazing opens up feeding sites where the
livestock have trampled the vegetation or left
patches of dung. Cattle grazing benefits birds
in another way: cattle do not eat rushes and
sedges, so clumps of these are left which make
ideal tussocks for nest sites. Several species
breed in them from April onwards, including
mallard, teal, snipe, redshank and yellow
wagtail.

Deliberate flooding Although man is now trying to reduce these areas which flood naturally, he used to flood meadowland deliberately. As an alternative to uncon-



Above: Cattle are one of the few mammals you are likely to see in a flood meadow. Yellow flags frame the field.

Right: Cuckoo flower is often found in wet meadows. Leaves break off the parent plant in the winter floods, become rooted in the mud, and produce new plants in spring.

Some summer inhabitants Breeding birds snipe, lapwing, curlew, yellow wagtail, mallard, teal, redshank, skylark, meadow pipit, whinchat Flowering plants marshmarigold, ragged-robin, meadowsweet, water forget-me-not, marsh pennywort, marsh-bedstraw, devil's-bit scabious, yellow rattle, great burnet, meadowrue, marsh valerian, marshorchid, greater bird's-foottrefoil, marsh speedwell. tufted vetch, water mint, lady's-mantle, lousewort, knapweed, marsh thistle Grasses cock's-foot, tufted hair-grass, creeping bent, yellow oat-grass, meadow fox-tail, sweet vernal-grass, Yorkshire-fog

Rushes and sedges soft rush, sharp-flowered rush, common spikerush, oval sedge, brown sedge, star sedge, hairy sedge Insects marbled white, common blue, meadow brown, small skipper, small copper butterflies; moths; craneflies; grasshoppers; beetles; bees; dragonflies



trolled winter flooding, special banks were built around a number of meadows. When more water came down the rivers than the banks could contain, it flowed via sluices into these meadows—or washes—and was stored there until the river levels dropped sufficiently for the sluice gate to be opened and the water to flow back into the river. In a normal winter, this would last from October or November through to March or April.

The Ouse Washes form the largest of these areas. Here, the land is divided into many grass fields which are grazed by cattle during the summer. It is a paradise for birds, both in the winter, when the floods attract some of the largest flocks of ducks and swans in the

country, and in the summer when many species breed in the marshy fields.

Irrigation skills In the 17th and 18th centuries the farmers of southern England realised that winter flooding greatly improved the quality of the grass. In Hampshire, Wiltshire and Dorset especially, they developed skilled techniques for flooding the fields deliberately, using the nutrient-rich chalk streams. To ensure that the water flowed evenly over the fields, and did not stand too long to form stagnant pools, parallel ridges were built across each field, at right angles to the stream. The ridges were about 1m (3ft) high and the gap between them anything from 2m (61/st) to 6m (20ft), depending on the slope of the ground. Along the centre of each ridge ran a shallow water channel fed from the stream through one or more sluices. The channel was stopped at the far end so that the water spilt over and ran down either side of the ridge. It then flowed across the intervening strip of grass before being drained away by a ditch at the base of the next ridge. By operating the sluices carefully the farmer could vary the speed and quantity of water flow.

The key period for irrigation was during January and February. Water in chalk streams is very constant in temperature. coming as it does from deep underground. and at this time of year is invariably warmer than the surface soil. Thus the irrigation not only fertilised the grass, but warmed it and so further stimulated growth. By March there was enough grass for the farmer to cease flooding and set his sheep to graze, perhaps three or even four weeks earlier than would have been possible on untreated fields. Later in the spring he removed the sheep, recommenced flooding, and then obtained a hay crop; in a dry year further flooding was done in the autumn. The technique gradually declined in the late 19th century and today only the remains of the ridges and furrows can be seen. One of the few working examples left is at Lower Woodford in Wiltshire.

Widespread drainage Careful management of water meadows and the southern chalk streams are now mainly a thing of the past and the washes, for example, are periodically threatened with drainage. Those alongside the river Nene have been drained and ploughed up, although during recent wet winters drainage authorities have been forced to flood the washes deliberately again. However, with the increasing cost of artificial fertilisers conservationists are beginning to think that nature's own fertilising floods—which are free—may be the more attractive, long-term proposition.

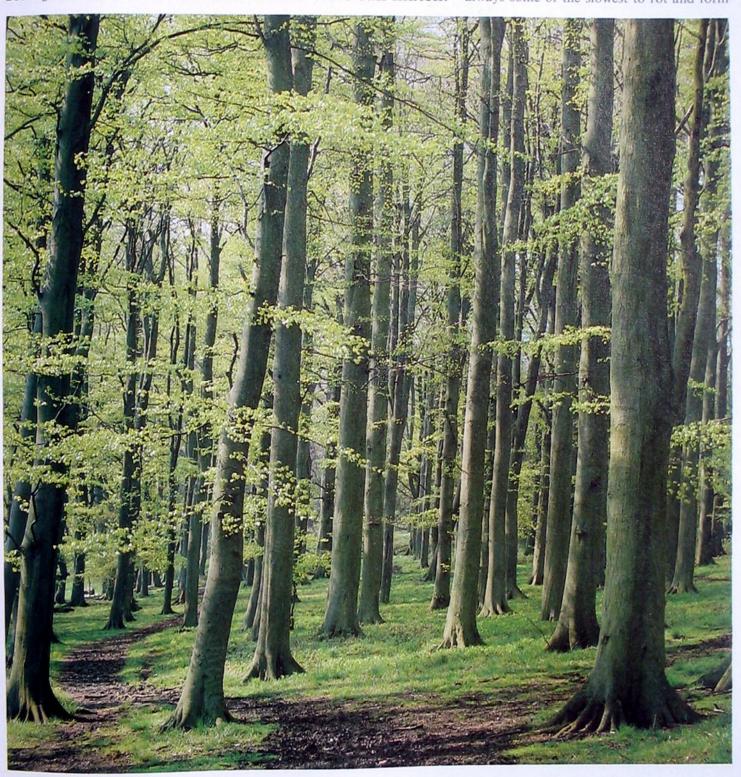
The value of floods to wildlife is being used as a weapon by conservationists in the fight against indiscriminate drainage. The most recent successful battle was fought over Amberley Wildbrooks, a big area of flood meadows on the river Arun in Sussex, where a flooding plan was turned down.

BOLD AND BEAUTIFUL BEECH

Early spring in the beech woods of Ashridge estate in Hertfordshire. The name beech comes from the old English word bece which has been adapted and incorporated into place names such as Buckinghamshire.

The beech is one of our most handsome trees. Its massive, smooth silver-grey trunk, the purity of its spring foliage and its vivid autumn colours give it a stature few trees can match. The beech is queen of the broadleaved trees. When it grows as an isolated tree its great limbs spread out to form a gigantic crown, but in a crowded beech wood the crowns are more compact. The trunks stand like the smooth, soaring columns of a cathedral, forced to grow tall in their constant struggle to reach the light. In these more cramped conditions most of the branches sprout from the very top of the trunk.

As summer progresses, layer upon layer of leaves cast such a deep shade that few plants can survive underneath the tree. The beech wood floor, therefore, tends to be rather bare, except for the carpet of dead beech leaves—always some of the slowest to rot and form





Male catkins always hang down. Each one is made from lots of male flowers. The catkins fall off when the stamens have shed

stamens



grow. The bracts now develop into cupules.

leaf mould (humus)—and a scattering of young saplings ready to grow up into any gap created by the death or fall of the tree above.

A sprawling network of surface roots anchor the tree to the ground and, because they explore only the upper layers of the soil, the beech is easily toppled by strong gales. In the long drought of 1976 the beech was particularly affected because its roots could not reach down to water deep below the surface.

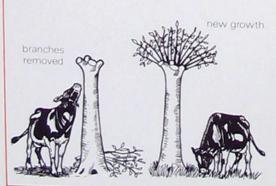
Native and cultivated The beech grows as a native tree only in southern England and south Wales. Ancient beech forests still survive on the Chiltern Hills in Buckinghamshire, in the Cotswolds and on southern chalk downs. Over the centuries and particularly in the last 200 years the tree has also been widely planted throughout Great Britain. Its value as an ornamental and landscape tree has been widely exploited in avenues, shelter-belts, hedges and hilltop clumps, serving to break two seeds up the bleak outline of rolling downland.

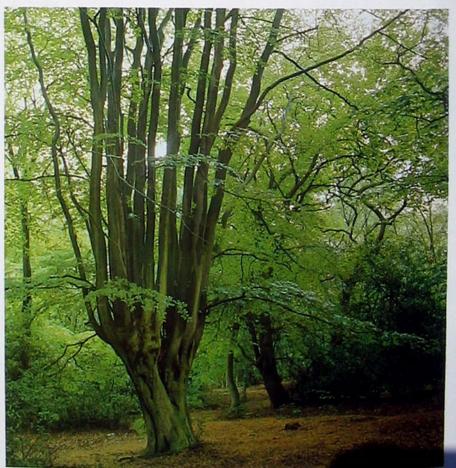
The beech grove at Slindon Park in Sussex contains lofty beech trees that are at least 200 years old. A superb beech avenue flanks the road alongside the Iron Age fort of Badbury Rings in Dorset. In summer the interlocking branches cast deep shade over the roadway and form a natural tunnel; there are 365 trees on either side of the road—one for every day of the year. And at Meikleour near Perth in Scotland there is a massive beech hedge a third of a mile long and standing 28m (90ft)

Pollarding

Pollarding is the lopping of the main branches of a tree at a height of 2-3m (7-10ft) above ground level, out of the reach of browsing livestock. Removal of these growing points stimulates most broadleaved trees to send out a mass of small branches from buds hidden below the bark of the main trunk. The new branches are used in much the same way as coppiced wood but have the added advantage that grazing pasture can grow underneath.

Pollarding used to be common, but as coal replaced wood for fuel, the annual lopping ceased and shoots were allowed to grow into great branches. You can see overgrown pollards in many woodlands. The tree shown here is in Epping Forest.





high-a daunting prospect for all but the most seasoned hedge-cutter.

The winter twigs of the beech are very distinctive: they are slender, smooth, and tipped with a spear-shaped bud. Additional buds are arranged alternatively along the length of the twig. Each of the long, pointed buds is wrapped in a series of overlapping protective brown scales.

Spring leaves The beech breaks into leaf in April. The oval leaves, tapering to a short point, are borne on short stalks. After they unfold from the buds, the fresh limp leaves are fringed with soft silvery hairs. The young foliage has a bright shining, almost translucent, quality; but as the season advances the leaves become stiffer and turn darker green with a glossy surface sheen.

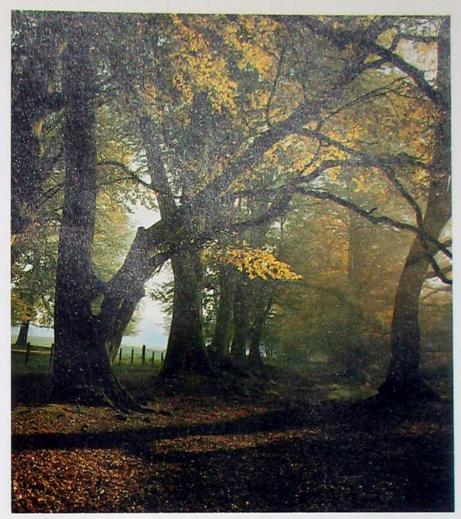
The flowers, which are usually half hidden among the emerging foliage, are wind-pollinated. The male flowers are grouped in clusters, hanging like tassels, and pollen is blown from their bright yellow anthers. The female flowers are in pairs, bound by a collar of prickly scales forming the cupule.

Nuts After fertilisation the cupule develops into a woody husk, clad in stiff bristles, enclosing a pair of three-sided, sharp-edged nuts. In October the ripe capsule splits and the four lobes peel back to allow the nuts, known as beech-mast, to fall out. The kernels are edible and delicious.

A really heavy crop of nuts is produced about every four or five years-known as mast years; this is an important time for forest wildlife. Mammals, such as badgers and squirrels, and birds, such as nuthatches and bramblings, are particularly fond of beech nuts and a good mast year can considerably increase their chances of survival through winter when other foods become scarce. In the past it was common to turn pigs out into woodland during autumn so that they could rummage about for nuts and acorns. This practice, called pannage, is still carried out on a small scale in the New Forest.

Autumn finery In autumn the beech has few rivals. The tree positively glows with colour, displaying a brilliant mosaic of flaming orange, russet and gold. Gradually the foliage darkens to a dull copper colour, reflecting the tree's gradual accumulation of waste products that form tannin. As the leaves fall, the ground beneath becomes smothered in a thick blanket of leaves. In the past mattresses used to be stuffed with dry beech leaves and they gave a comfortable, if noisy, night's sleep. In France they were called *lits de parliament*—talking beds—because of the noise they made.

Life under beech Pure beech woods are ideal places for walks on a hot summer's day. Occasionally you see holly, yew and wild cherry growing among the trees, but on the whole few plants can tolerate the deep shade. Two interesting species are the yellow birdsnest and birdsnest orchid, both of which feed



off rotting vegetation and therefore do not need sunlight to help make their food. All kinds of fungi flourish in the autumn, including the virulent death-cap, our most poisonous toadstool, and bracket fungi are common on tree trunks.

Mixed beech woods are generally far more hospitable to wildlife. The sudden shafts of light that beam down through gaps in the canopy of oak, sycamore or perhaps horn-beam encourage all kinds of wild flowers to grow-helleborine, wood anemone, arum lily, yellow archangel and bluebell, to mention just a few. Bramble, bracken, heather and mosses often carpet the ground, providing protection for numerous insects and birds.

Timber In common with most of our native trees, beech was used for firewood, even though it does not burn particularly well. Queen Victoria was supposed to have preferred to have wood from Burnham Beeches, near Slough, burned on the fires at Windsor Castle.

Beech trees used to be pollarded every 20 years or so. Use as building timber is limited because beech decays quickly. The wood is rather soft and springy but this has always been an advantage in furniture making.

The furniture industry has long been centred at High Wycombe in the heart of the Chilterns and, until quite recently, the surrounding beechwoods were the hub of a flourishing cottage industry.

Above: the edge of the mature beech woods of Ashridge estate in autumn, where many of the leaves have already fallen. Younger trees and beech hedges keep their leaves until the following spring.

Below: A young beech seedling with the remains of the seed case still attached to the young shoot and the cupule lying on the ground.



SNAILS WITHOUT SHELLS

Slugs are closely related to snails, but do not have a visible shell and can therefore squeeze under stones or logs for safety.

As hermaphrodites they can mate with any slug and lay eggs.

Slugs are hermaphrodites which means that each slug has male and female sex organs, each can mate with any other slug and all

slugs can lay eggs.

Slug eggs, which are laid in loose soil or under decaying vegetation, are white or transparent in colour and measure about 3mm (\frac{1}{8}in) in diameter. Although usually laid in spring or autumn, eggs of the field slug can also be found throughout the winter months. The time taken for eggs to hatch depends on the temperature and varies from three or four weeks during warmer weather to several months in winter. Newly hatched slugs are similar to the adults although they may have a different colour. The time taken for them to mature varies from six months for the field slug to 18 months for the keeled slug.

Garden species Slugs found in gardens rarely measure more than 5cm (2in) in length. The most common of these, the field slug, feeds at the surface or just below the ground. In humid weather it also feeds on leaves of plants above the ground. Two other common slugs, the garden slug and the keeled slug, keep below the ground, burrowing to depths of 30cm (12in) or more, although they can be found feeding above ground level at night. All three species can be found under stones, rotting wood, compost heaps and other garden debris.

The slug's diet includes a wide range of living plants, as well as decaying vegetation. Slugs often cause considerable damage, especially to potatoes, strawberries and seedlings of many kinds. They have one weakness, however: they are partial to beer. If they are particularly troublesome in the garden, advantage can be taken of this by trapping them in disposable cups—partly filled with beer—sunk into the soil.

Slugs v. snails Unlike their close relatives the snails, slugs have no external shell to protect their delicate bodies from dehydration and from attacks by predators. However, many possess a small plate-like shell on the back under the mantle. This lack of protection would seem to be a disadvatage; yet because they do not have a cumbersome shell, they can move about fairly rapidly and also







shelter in small crevices which are not accessible to snails. Slugs also live in a wider range of habitats than snails as they do not need the large quantities of lime necessary for forming

a shell.

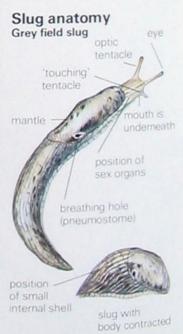
Mucus trail Slugs secrete two types of mucus from the foot which help them climb smooth surfaces and glide over rough ones. The mucus is left behind as a 'silvery trail' often noticeable on the soil or plant leaves.

Slugs are also covered with a protective layer of mucus that few predators relish. In fact slugs have few natural predators in the garden (these include thrushes, starlings and hedgehogs) and their numbers are not greatly threatened.

Above: The colour of the field slug (*Deroceras* reticulatum) varies from white to dark brown, with a mottled pattern of darker markings. You can see traces of mucus (a sticky white slime) left in a silvery trail behind the slug.

Left: Hollowing their way through a strawberry are two garden slugs (*Arion hortensis*). The body is dark brown to black in colour, with a darker longitudinal band on each side. The two tentacles have eyes on them.

Left: The pearly white eggs of the field slug measure on average 3mm ($\frac{1}{8}$ in) in diameter; the shell protects the offspring inside from water loss. Loose soil is a common home for slug eggs, as well as rotting bark or other decaying vegetation.



ELUSIVE OTTER OF THE WATERSIDE

Otters are fascinating animals to watch as they have many playful and endearing habits—sliding down muddy banks and twirling about in the water, for example. But because of their elusive nature and the fact that populations are dwindling, they are not easy to find.

Otters feed mainly on fish and for centuries gamekeepers have waged war on them under the impression that otters damaged fish stocks. Otters certainly do take trout, and the occasional salmon, but they are very opportunist feeders and will also take frogs, tadpoles, and even water birds such as moorhens which they catch by coming up underneath birds as they swim, and pulling them under the water. Eels are also a common source of food.

The otter looks like an overgrown 'water weasel': and that's exactly what it is. Like its smaller relatives including the stoat and weasel, it has a long body, long tail and short legs. But it is the only native one whose search for food takes it into the water, and it is this amphibian existence which affects every aspect of its way of life.

Strong swimmer The otter's body is suitably shaped to move fast in water as well as on land. At one end its small head merges with its thick muscular trunk, while at the other end its powerful tail—or rudder—tapers from a broad base to a point. Its five-nailed toes are webbed like a duck's and transform an ineffectual dog-paddle into a powerful swim-

ming stroke. Altogether the otter is beautifully streamlined; it swims on the surface by paddling with its feet, and when swimming fast it flexes its supple body and tail. Sometimes when it is playing it may use a 'porpoising' action through the water.

Furry protection As the otter is frequently going in and out of water it needs a coat that can act as both mackintosh and warm blanket: this is exactly what its rich, thick fur provides. The coat is made up of two layers: the visible one is long and coarse, while the under-fur is fine, glossy and so thick that it is almost impossible to part. When the otter submerges, the under-fur traps a layer of air bubbles, which insulates the animal by preventing water getting in. This layer also creates the characteristic silver colour that otters have when they are swimming under water-and the trail of bubbles which marks their progress.

When the otter climbs out onto a beach or bank, water cascades off its body, and the long guard hairs form bunches, giving the coat a distinctly spiky appearance. To dry off it has a good shake, and often also rolls on the grass. The otter spends a great deal of time grooming and generally caring for its coat.

How does the otter stay under water in order to catch its prey? Just before it dives, it takes a very deep breath (sometimes a gasp is clearly audible). Because its lungs are large,



that single breath will keep the otter going for three or four minutes, giving the creature time to swim up to a quarter of a mile, catch a fish or escape most dangers.

The otter has adapted other features to underwater swimming. Its ears hardly project beyond its thick fur so as not to spoil the stream-lining of its body. When it is submerged, both its ears and crescent-shaped nostrils are closed by special valves. The otter can hear little or nothing underwater, but relies on its sight which is especially adapted for this purpose. Round the eyes are special muscles, rather like those of a cormorant, which apparently adjust the focus to compensate for the visual distortion caused by the water. The otter therefore seems to see even better in the water than out of it, and it certainly normally hunts by sight.

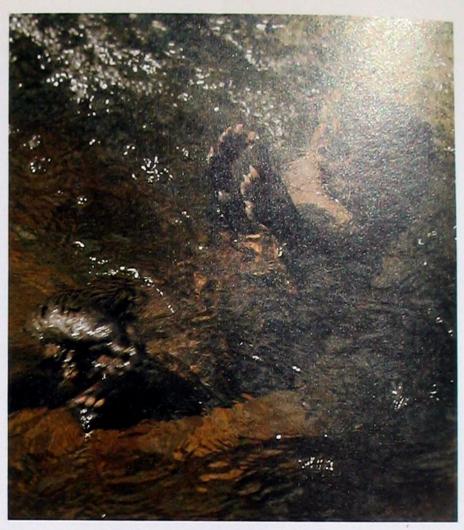
Sometimes when the otter is in choppy or murky water, even eyesight may be useless. The otter then relies on its whiskers. It has bunches of these on its cheeks, throat and eyebrows. These whiskers are so sensitive to vibration that an otter can chase fleeing fish in dark water.

Like other amphibious creatures such as the frog, the otter has rather bulging eyes positioned near the top of its flat head. This gives it a good view in front and above, but apparently not below, since it seems unable to catch fish swimming underneath it. Instead the otter usually comes up on its prey—a good tactic where fish are concerned, since they too can scarcely see what is going on below them. When hunting for eels (a favourite food) the otter will turn over stones at the bottom of the river with its paws.

Smelly messages Contact with other otters is maintained chiefly by scent messages in the form of a special anal jelly, produced by a pair of anal glands under the tail, and droppings (spraints). The full significance of these messages is not known, but research has shown that the chemical character of the jelly is as individual as a signature and that otters can distinguish between deposits left by different otters. The jelly may also be used by the dog otter to tell whether a particular bitch is 'on heat'.

The spraints are much more easy to find than the jelly. They are deposited in places where other otters are most likely to find them—on ledges, under bridges or on rocks in mid-stream. Good sites for depositing spraints will be used year after year. The spraints are dark in colour and have a very distinctive, not unpleasant, musky smell: once smelt never forgotten. They can be any length up to 10cm ($3\frac{1}{2}\text{in}$) and any consistency depending on what the otter has been eating. Examination of their contents gives a good idea of the otter's diet as the hard parts of its prey, such as fish bones, pass through the gut without much change.

Mating Otters usually move singly and mainly at night, with exclusive rights on an



average 15-mile stretch of river. They have more than one resting place (holt) between which they move in an unpredictable way. Although by day otters lie up on their own, a bitch on heat immediately becomes an object of interest to the dogs (males) in the neighbourhood. She will usually only mate with one otter but sometimes several may pursue her and fight fiercely for her favours. Amid much squealing the rival males snap at each other, particularly in the region of the genitals; broken penis bones are quite a common casualty among dog otters.

Even for the successful male otter his difficulties are not over. He must rendezvous with his bitch in the dark; often he does this by engaging her in a whistling duet. First one whistles, then the other; only when they have got a bearing on each other's position do they approach slowly. Otters mate whatever the time of year—usually in the water. Since pairing may last 15 minutes; in winter this is a considerable tribute to the effectiveness of the layer of air insulating the otter's body.

Breeding holt The couple usually stay together for a few weeks, but before the cubs are born the bitch drives the dog away. Two months after mating, the bitch gives birth. However, very little is known about where she gives birth or how she looks after her cubs in the wild.

Otters with riverside territories may well give birth in places similar to their 'lying-up'

Above: Otters are very playful and tossing pebbles about is a popular pastime, as this otter shows. Holding one between her dexterous forepaws like a small football, she will toss it into the air and retrieve it underwater.

Below: This characteristic pose of the otter is known as tripoding; balance is kept by the hind feet and the base of the outstretched, muscular tail. From this elevated position the otter can keep a good look-out.



holts, for example in old burrows, natural hollows in the riverbank, under old tree roots or hollows under boulders. The holt has to be situated well above the water level of winter floods and well hidden. Another possibility is that the cubs may be born in holts away from the water's edge so that there is no danger of them drowning before they are old enough to swim. The mother would then bring them down to the river as soon as they were old enough to be moved. Coastal otters probably make use of caves, while in fenland areas such as East Anglia surface nests made out of reeds have been discovered.

Vulnerable cubs The young-between one and five in a litter-are born blind, toothless and are about the size of a rat. In this helpless state they utter soft twittering cries which develop into chirping or chittering. The cubs are not weaned for four months, and grow relatively slowly. They stay with the mother for anything up to a year, during which time she rears them without the male's assistance, and defends them fiercely when necessary. In the past the female otter has won reluctant admiration from gamekeepers and huntsmen for the way that, even when wounded, she returns to her litter, an instinct which has sometimes caused her death and that of her cubs. Sometimes if her cubs are in danger, she may summon them with a sharp whistle. There are also reports of dogs and people being attacked because they have threatened

the young or accidentally disturbed them.

The young leave the holt for the first time when they are about two months old; but they are nearly twice that age before they make their first excursion into the water, because their long silky fur is not yet water-proof. The cubs do not take to water naturally. The mother has to coax them and push them in, or even take them in her mouth and dunk them forcibly. Once in, however, the cubs are quick to adapt to their new watery home and are soon beginning to dive and 'rough and tumble' with one another.

Few animals enjoy a good game as much as otters seem to. They even play on their own as well as in company with other cubs or together as adults. In captivity and in such surroundings as those provided by otter haven projects, they will also play with their human benefactors. They seem to love sliding down river banks in the mud or snow and also enjoy playing with pebbles. Zoologists still don't understand why some animals are more playful than others, but play is demonstrably an important part of the otters' life; and their apparent sense of fun certainly makes them one of our favourite mammals.

Later articles will show how the otter searches for food, whether it competes with the mink for available nourishment and also how it copes with winter and the loss of breeding sites



EUROPEAN OTTER (Lutra lutra) Also called water weasel, water dog, burn dog, tok

Size male weighs 10.3kg (23lb) and total length is 1.2m (4ft); female weighs 7.4kg (16lb) and is 1m (3ft 3in) long

Colour rich brown, often paler throat and lip markings Breeding season all year Gestation period 62 days No of young 1-5; usually 2-3

Lifespan unknown in wild otter; 20 years in captive North American otter Food fish, amphibians and crustaceans. Also small mammals and birds Predators No natural

Distribution in England mainly restricted to south west, East Anglia; also parts of Wales; more numerous in Scotland



No haven for the otter

It is clear that the European otter is vanishing from many of its haunts—chiefly because of man-made changes to its environment. Polluted rivers, for example, will affect the food supply and detergents in the water can destroy the otter's indispensable waterproofing; once its diving suit is damaged, the otter can no longer resist the wet and cold and so succumbs to both and dies. Its numbers have declined so much in England and Wales that it is now a protected species. Positive steps have been taken to protect its environment and promote its increase by the setting up of nationwide otter haven projects. Because there is a healthier distribution in Scotland, the otter is not yet officially an endangered species there, although Parliament is currently debating whether to have this animal protected in Scotland as well.

Typical otter country in Wester Ross, Scotland—an undisturbed riverbank and plenty of natural hollows behind the boulders, providing ideal breeding sites for the secretive otter.

the chamber is well above the winter flood-level

The breeding holt

Otter holts are always well-hidden. The female needs to avoid drawing attention to the holt, especially when the cubs are very young. Thick bankside vegetation or an underwater entrance allows the otter to enter or leave the holt unseen.

otters may line the holt with vegetation

The ation to a hore very

a holt may have more than one entrance

FUNGI THAT FRUIT IN SPRING

The astonishing assortment of mushrooms and toadstools that appear as if by magic are the fruiting bodies of fungi-often colourful, sometimes deadly —nature's dustmen.

The emergence of the colourful and often grotesque fruiting body of the fungus is the climax to a rather unobtrusive existence that can only be properly observed with the aid of a microscope. A fungus has one of two main life styles: a saprophytic fungus digests the compost of decaying plant remains that accumulate throughout the year; a parasitic fungus feeds directly from living plants and animals. A fungus cannot manufacture food as green plants do and its main body, which consists of a web of delicate threads called hyphae, infiltrates its food supply.

Saprophytes play a vital role in nature's waste disposal system. Over one ton of plant rubbish (leaves, twigs, branches, etc) per acre

falls each year over a woodland floor. The fungi help to break the pile down and if it were not decomposed from year to year our woodland would gradually become buried in its own waste. In addition, saprophytes help to recycle raw materials that would otherwise be unobtainable for green plants, which need new soil minerals as well as sunlight for their growth.

The majority of fungi produce mushrooms and toadstools—the fruiting bodies full of spores—in summer and autumn, often after heavy rain. Most mushrooms and toadstools are killed off as winter approaches; because they are composed of up to 90% water, they are quickly destroyed by frost. However a few species can be found in spring, either because they are tough enough to survive the winter or because their fruiting season begins in spring.

If you inspect dead elder branches you will, sooner or later, come across the jew's ear. It forms a brown, flabby, fruiting body which looks like an inverted cup and measures up to 8cm (3in) across. The outer surface is smooth and velvety, while the inside is wrinkled with shallow folds rather like an ear. You only need to squeeze it to see why it is classified as a jelly fungus. When fresh it is limp with a soft, rubbery texture; as it dries out it becomes shrivelled and leathery. The name that has been adopted for it is somewhat inappropriate; it was originally known as Judas's ear,

Jew's ear (Auricularia auricula-judae) usually found in spring on dead branches of elder trees. Edible.









Left: Common ganoderma (Ganoderma applanatum) found all year on many broadleaved trees. Note surrounding leaves covered in spores. Poisonous.

Right: Scarlet elf cup (Sarcosypha coccinea) found in late winter and early spring on hazel. Poisonous.

Below: St George's mushroom (*Tricholoma* gambosum) found from spring to autumn at the base of hedges and on sand dunes. Good to eat.



Left: Common morel (Morchella esculenta) found in spring in clearings and beside hedges. Edible, with a good flavour.

stemming from the ancient belief that Judas Iscariot hanged himself from an elder tree after betraying Jesus. Jew's ears are considered a great delicacy in China, where they are cultivated on stacks of oak logs.

The common morel is a particularly oddlooking fungus that appears during spring in woodland clearings and under hedges. Its extraordinary cap varies in colour from dirty white to pale brown and resembles a bath sponge. It belongs to the Ascomycete group of fungi, the spores of which are formed in special cells called asci; these line the surface of the honeycomb pits. The pale yellow stems are squat, hollow and very brittle. The fungi are edible and can either be cooked fresh or dried and added to soups and stews.

The striate birds nest fungus first appears in spring and continues fruiting until autumn. It grows on woodland debris such as fallen branches, sticks and cones, often in dense colonies. The red-brown cups, about 1cm (½in) across, are grooved: the outer surface is clothed in fine bristles, but the inside is smooth and glossy. The spores are contained in small bodies called peridioles which lie in the 'nest' just like a clutch of eggs. The spores are dispersed when raindrops splash into the cup, knocking the 'eggs' over the side.

A number of species form 'fairy rings' as the fungus gradually spreads through the soil, like a drop of ink on blotting paper, getting wider each year as it produces mushrooms at is St. George's mushroom, so called because it springs up around St George's Day (April 23). The creamy-coloured cap up to 10cm (4in) across is silky smooth on top and fleshy. The margin of the cap is usually wavy and turned in on itself. The stems are rather stocky and pale brown or creamy yellow in colour.

The common ganoderma is an example of a hardy species of bracket fungus that can be found throughout the common displacement to the common displacement the common displacement to the common displa

the edge of the ring annually. One of these

hardy species of bracket fungus that can be found throughout the year clamped tightly on to tree trunks, especially those of beech. It is a parasite which slowly drains the life out of its host. It has an extremely hard, rusty-brown cap with white margin and undersurface covered in tiny pores from which literally billions of spores rain down in summer. It grows a new layer of pores each year and if you cut a cross-section you can count these layers and tell its age.

Another unusual fungus that is easy to find in spring is King Alfred's cakes, which grows mainly on ash trees. It owes its name to the fact that it resembles lumps of charcoal—the legendary result of King Alfred's disastrous episode in the kitchen. In many country areas it is also called cramp balls and used to be carried by older villagers to ward off rheumatism.

One of the most colourful fungi found in winter and early spring is the scarlet elf cup, which grows on sticks and brushwood. It is particularly common in the West Country. During the Christmas season it is sometimes brought indoors on twigs and used as a table decoration with mosses and dried flowers. The pale outer surface of the cup, which is stalked like a tiny goblet and covered with fine down, contrasts sharply with the rich scarlet interior. The spore-containing asci are embedded in the brilliant red lining of the cup. When the spores are ripe they are pushed to the surface and then dispersed by the wind or rainwater.

Although a number of fungi that grow in the British Isles are edible—and some are even delicious—it is not worth your while to try even the smallest morsel unless you are quite sure you know what you are eating. Choose fully grown species because they are easier to identify and, to be safe, try a little at a time.



Above: King Alfred's cakes (Daldinia concentrica) found all year on dead ash trees and occasionally beech or elder.

Left: Striate bird's nest (Cyathus striatus) found on dead tree trunks and twigs from spring to autumn. Poisonous.

THE WINDHOVER: A SKILLED HUNTER

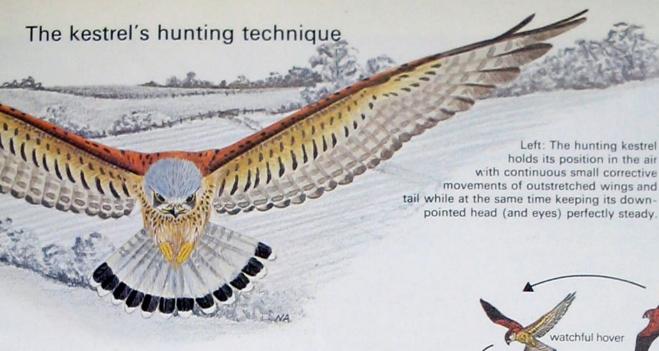
The kestrel's old folk name—the windhover—catches the essence of this bird whose most characteristic posture is its skilful, seemingly effortless hovering. If you see a bird with wings winnowing, tail fanned out and head down it's probably a kestrel after prey.

A pair of kestrels at their woodland nest; as with many birds of prey, the male (left) is smaller than the female (right). The nest was not built by this pair; it is an old one made by another bird (possibly a carrion crow) and taken over by the kestrels. When the eggs-up to five in number-are laid, the female does most of the incubating while the male hunts, periodically bringing his mate food-such as the vole she is holding in her

The kestrel is our most common and widespread bird of prey; it is also unique in the way it has come to terms with man and become an independent and resourceful city dweller. Its urban takeover bid has been very successful; in a special survey carried out in 1977 no fewer than 337 breeding pairs were reported in London, at least seven of them right in the heart of the city. The kestrel has also learned to exploit the thousands of miles of infrequently mown grassy motorway verges which harbour the small rodents that make up its principal food. In fact, a stretch of country motorway is one of the best places to see these slim, long-tailed members of the falcon family. Male and female do not look alike. The striking blue-grey head and tail and light chestnut back spotted with black identify the male kestrel, while the female's plumage is barred and streaked in brown and reddish-brown colours. Both sexes have a conspicuous black band on the end of the tail which is clearly visible when the birds are hovering, and both have creamy underparts streaked with black or dark brown.

Varied feeder Towns and motorways are not, of course, the only haunts of the kestrel. It frequents downs, heaths, moors, mountains, parkland, farmland and cliffs—almost every land habitat barring the middle of thick woods where there is not enough room for its particular style of hunting. (In these woods





the kestrel's place is taken by the sparrow-hawk).

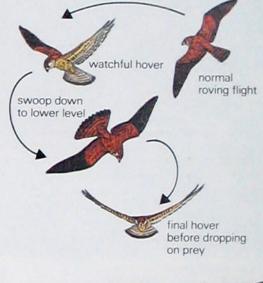
One secret of the kestrel's success is its ability to adapt to a very varied diet. In country areas small rodents such as mice and voles form nearly two thirds of the kestrel's food-making the bird a distinct benefit to the farmer. The next most important items of diet are insects, particularly grasshoppers and beetles, and some small birds such as finches. Some enterprising individuals have been known to take turtle doves and lapwings-birds almost as large as themselves.

In towns where small outdoor mammals are in short supply, the kestrel preys principally on small birds such as house sparrows and starlings. Distance is no serious obstacle if the kestrel knows that a good supply of food awaits it at the end of a journey; for instance, one pair of outer London kestrels flew five miles regularly to hunt at a sewage works frequented by starlings.

Skilled hunter The kestrel is an exceptionally keen sighted bird—as it has to be since it often hunts from heights of up to 60m (200ft). As it hovers, the kestrel keeps its head absolutely still—eyes fixed on the prey far below—while maintaining its position in the air with constant small adjustments of wings

Right: To catch its prey the kestrel must be fast and accurate. When its keen eyes have picked out the movements of a mouse or vole on the ground below, the kestrel swoops down on it in a series of stepped descents. The kill is made with the strong, fearsomely sharp talons which clutch the victim in a deadly grip. Open ground is essential for this type of hunting-in dense woodland with tangled undergrowth the kestrel could severely damage its long, pointed wings.

Below: After the kill, the kestrel sometimes 'mantles' its prey, with its wings outspread and its tail forming an almost circular cover. It is thought this is done to screen the prey while the bird recovers from the flurry of the hunt.









and tail. Even when facing into a high wind, the head remains quite steady though the body may be wobbling frantically from side to side and the wings and tail lashing furiously.

Once the victim is spotted, the kestrel swoops towards it at great speed, sometimes catching up short halfway to adjust position, and seizes the unfortunate animal with its powerful outstretched talons. The prey either dies instantly from the impact, or when a talon pierces a vital organ during a tussle on the ground. If the kill is made on a roadside verge or other exposed place, the kestrel flies off at once to a private perch, clutching its prey firmly in its talons. Alternatively, the kestrel will crouch over its kill on the ground, 'mantling' it with outspread wings and taillike an open umbrella. It is thought that this is done to screen the prey from other birds while giving the kestrel time to regain its breath after the exertion of the hunt; it is an aspect of behaviour typical of all falcons. Small birds are sometimes caught on the wing in a swift 'swoop, clutch and away' movement. The prey is usually carried off to a suitable perch or post, where the kestrel can eat it in peace and quiet. Fence posts, telephone wires and tall trees are often used as convenient perches from which the kestrel can watch for prey; its alert, straight-backed posture on these perches is almost as characteristic a pose as the hovering. The swoop down on a victim is made just as effectively from this position.

Choosing a nesting site Like other falcons, the kestrel does not build a nest. In the country it often lays its eggs on cliff ledges, in hollow trees or, in wooded areas, in the old nest of another bird-particularly that of the carrion crow. On the Orkney Islands which have a good supply of food to offer but neither cliffs nor trees, the kestrel has learned to nest in long heather on the ground.

In towns, however, the kestrel's adaptability is especially evident in its catholic choice of nesting site. Ruined and deserted buildings have long been used as substitutes for cliffs and from these it seems to have been a simple stage to nesting on occupied buildings. Most early town-breeding records refer to public buildings like churches. One famous pair of kestrels managed to raise their family on the tower of the Imperial Institute in South Kensington! More recently, kestrels have been discovered breeding in window toxes on high-rise buildings—perhaps the ultimate in city acclimatisation.

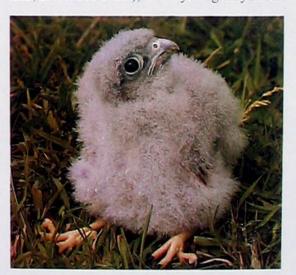
Kestrels are great opportunists; in the Netherlands, for example, they were quick to benefit from the invasion of rodents on the newly reclaimed Zuider Zee polders, and readily occupied the large open-fronted nest boxes put up for them by the thoughtful Dutch.

Courtship display Kestrels are rather solitary birds, so it is only during courtship that you are likely to see male and female together. The pair soar up into the sky with extended wings, the male usually higher than his mate. Soaring is followed by much wilder movements—the male repeatedly 'stoops' upon the female like a fighter plane in aerial combat, sometimes even brushing her with his wings. This dramatic display is often accompanied by loud, rather shrill 'kee-kee-kee' calls.

The soaring display flight is perhaps the only time when you might confuse the kestrel with our other small bird of prey, the sparrowhawk. Both birds are similar enough in size to cause confusion, both have a long tail and both soar in the breeding season. However, if you watch for the sparrowhawk's distinctive low-level interception method of killing (as opposed to the kestrel's characteristic hover), and broad, blunt wings (unlike the kestrel's long pointed ones) identification should not be too difficult. Sometimes, however, the kestrel's wings can look broad and blunt-ended when they are stiffly extended during soaring.

Raising young The female kestrel lays her eggs between mid-April and mid-May, at intervals of two to four days. The eggs, from one to five in number, are a rich, mottled red brown in colour.

The female incubates the eggs for about a month, sometimes assisted by the male. Occasionally, she will start incubating as soon as the first egg is laid (instead of when all are laid, as is more usual), so the young may hatch



out at two- to four-day intervals. This is an adaptation for species survival, for in years when food is scarce the smallest and weakest (and probably the youngest) quickly starve to death; in this case it is better to raise just one healthy, strong chick rather than four or more weaklings.

Both male and female take part in feeding the chicks; these develop not one but two successive coats of greyish fluffy down before fledging at about 28-30 days old. The young are meat eaters from the start of their lives and greedily swallow the chunks of flesh and insects offered them by their parents until they are old enough to leave the nest and hunt for themselves.



Above: Female kestrel and her brood on a rocky cliff ledge nesting site. Both male and female feed the chicks, bringing voles, mice and insects.

Left: The kestrel chick has two successive coats of down, the first shorter and thinner and the second longer, coarser and usually darker. Feathers start to appear when the chick is between 12 and 20 days old, and the chick is able to fly at anything from 27 to 39 days.

Kestrel (Falco tinnunculus), also called the windhover; 34cm (13½in) long from beak to tail; distribution very general, including open woods, moors, cliffs, farmland, motorway verges and city centres.



How birds see

Vision is the dominant sense of nearly all birds. In most, the eyes are placed so far to the side of the head that they have mainly monocular vision-each eye scanning a separate area-a feature shared by all hunted creatures who depend on vision to warn them of possible danger. The thrush turns its head sideways to look (not to listen), and some birds, such as the woodcock, even have all round vision. Birds of prey and owls have eyes set more to the front of the head, offering a wider angle of binocular vision-vitally important for judging distance. The kestrel, for example, has a 150° field of vision, over the middle 50° of which both eyes work in binocular vision, scanning an overlapping area.

We see only the cornea of a bird's eye, but the eyeball within the skull is proportionately huge. For example, if our eyes were like the starling's, they would be as big as tennis balls! A bird focuses by means of powerful muscles which alter the shape of the lens. Light passing through the lens falls on the retina—a complex surface of minute cells. Part of the retina—the fovea—is more densely packed with cells: in the buzzard there are one million per square millimetre, while in man there are only 200,000. The more cells there are, the greater the detail transmitted to the brain. (Some of the cells are responsive to

light, while others respond to colour.) Elsewhere within the bird's eye is a small, fleshy projection called the pecten, which supplies oxygen and nutrients to the cells and also enhances the ability of the eye to detect movement. Many birds have oil droplets within their eyes which serve to sharpen contrast (as a photographic filter does), making it easier for the bird to distinguish its prey. Also birds have a third 'eyelid'—a transparent nictitating (winking) membrane—which moves sideways across the cornea and keeps it moist without interrupting vision. This makes birds look as though they blink.

Accuracy is crucial for a hunting bird like the kestrel which relies on its keen eyesight, first to spot prey and then to catch it; the kestrel's eyes are therefore positioned sufficiently far forwards to give it binocular (three-dimensional) vision over a third of its visual arc.



NATURE'S WILD WOODLAND GARDEN

Primroses and wild daffodils, two of our most cherished spring flowers, grow in hedgerows and meadows, open clearings of woods, and also in weedy areas of gardens. Once established in the right soil conditions, they bloom in profusion and multiply, making rich, golden carpets of blooms.

Wild daffodils are particularly common around Newent in Gloucestershire. In the 1930s special trains took Londoners to see the spectacular drifts of yellow flowers.

Although wild daffodils—Lent lilies—are less widespread than they were, they are still prolific in the west and south of England and Wales, and some colonies persist in eastern England in old woods and churchyards. Their numbers have been much reduced not only by indiscriminate picking but also by drainage of land—daffodils do better in damp ground—and by their deliberate removal from pastures because their bulbs are slightly poisonous to grazing animals. However, where they are left undisturbed they continue to flourish, sometimes in the most unlikely places such as the banks of the M5 motorway.

The Lent lily is the only truly native type of daffodil in Britain, although some foreign species and hybrids have escaped from gardens and are now widely naturalised. It has solitary, drooping flowers with delicate pale yellow petals and a darker yellow trumpet. Possibly the Tenby daffodil, the symbolic flower of Wales, is also native; if it is a garden escape, it certainly escaped a long time ago. It differs from the Lent lily in that it has deeper yellow petals and is slightly taller.

The primrose was given the name prima rosa-first rose of the year-by medieval scholars. It is nowadays often difficult to find around towns; away from over-enthusiastic collectors, however, primroses still flourish in old grassland and hedgerows or in woods.



Like many other common and easily recognised plants, the primrose has been put to numerous uses. Its flowers and those of its cousin, the cowslip, were recommended as a flavouring in a 17th century recipe for minnows fried with egg yolks, and vast quantities of primrose and cowslip blossoms went into country wines and vinegar. Primrose leaves were boiled with lard by medieval New Forest woodmen to make an ointment for cuts.

Primrose flowers are usually pale yellow with a darker yellow eye in the centre. They have lines or honeyguides on the petals reflecting ultra violet light which, although invisible to us, is seen by insects and directs them to the nectar in the base of the flower tube.

Some primroses in the woods of south Wales have pinkish flowers, and in some plants the flowers grow on a common stalk instead of all springing separately from the base of the plant. With such variability existing naturally in wild primroses, it is not surprising that gardeners have seized on the opportunity to single out oddities-the long stalked, or large flowered, or brightly coloured mutants which, by hybridisation with cowslips and oxlips, have given birth to the enormous range of polyanthus varieties we see in gardens today.

Escapes While primroses and daffodils have been hybridised in gardens in seemingly endless permutations, other plants have escaped

Looking at primrose flowers

Many plants have special mechanisms to ensure cross-pollination (the exchange of pollen for fertilization). Primroses have two types of flowers-pin-eye and thrum-eyewhich grow on different plants. Seeds are only produced when one type of flower has been pollinated by pollen from the other type of flower.

The pollen grains of thrum-eye flowers are large and only fit onto the surface of a pineye stigma. Similarly, the smaller pollen grains of the pin-eye flower only fit the surface of the thrum-eye stigma. The structure of the two flowers is neatly arranged so that visiting insects transfer the right pollen to the right stigma.

Pin-eye flower Thrum-eye flower bee fly stigma. on a long style stamen stamen pollen rubs ovary on to the insect's proboscis nectar

As a long-tongued insect reaches for nectar in a pin-eye flower pollen rubs on to the middle of its proboscis. If the insect then flies to a thrum-eye flower, this pollen is at just the right level to rub off onto the short thrumeye stigma.

At the same time the insect's head and base of its proboscis are covered with more pollen from the thrum-eye stamens. If the insect now moves to a pin-eye flower, this pollen is in the right position to rub on to the tall pin-eye stigma.

from gardens to the countryside. The spring crocus is a familiar spring flower of gardens that is occasionally found growing wild in meadows and woods. You can see it naturalised in a field at Inkpen in Hampshire.

The sand crocus, a relative of the spring crocus, is however a native plant which grows by the coast in south west England. It is uncommon probably because it is not hardy enough to withstand our winter frosts; it is much more widespread farther south in Europe. The sand crocus does not look much like its garden counterpart: its leaves are remarkable for being thin and twisted like a corkscrew, and the flowers are purple on one side and pale green on the back.

Tenby daffodil

Pembrokeshire.

Ht. 30cm (12in).

Primrose (Primula

May in woods and

shady places.

Ht. 15cm (6in)

Purple crocus

(Crocus purpureus)

flowers March-April

here

vulgaris) flowers Feb-

(Narcissus obvallaris)

flowers April in Tenby,

Wild daffodil (Narcissus pseudonarcissus) flowers March-April in damp woods, meadows and by riversides. Locally abundant. Ht. 23cm (9in).



Sand crocus

flowers April on

sandy grassland

in S Devonshire.

Ht. 15cm (6in).

(Romulea

columnae)

A SHORT LIFE BUT A BUSY ONE

The life cycle of bumble bees is squeezed into a few short months; all the members of a colony (begun by a single queen in spring) die in autumn except new queens, which hibernate.

Bumble bees, like honey bees and ants, are social insects and live together in colonies; unlike those of the other two, however, bumble bees' colonies are annual ones, newly built each year. Bumble bees do not store honey to tide them over winter, so in autumn all members of the colony die except the young mated queens which hibernate until spring in the shelter of a hedgerow, heap of moss or pile of leaves, normally burrowing a few inches below the surface of the soil. The rest of the life cycle is squeezed into our few spring and summer months.

Building a nest In early spring you can often see a queen bumble bee, newly emerged from hibernation, blundering around close to the ground as if she were looking for something. What she is searching for is a suitable place to nest. Some species choose underground sites—a leaf-filled hole beneath the roots of a decaying tree, or a disused hedgehog or mouse nest—while others, the carder bees, make an above-ground, ball-shaped nest of moss, grass and leaves which they weave or 'card' together.

Once the nesting site is established, the queen makes a circular chamber, about 3cm (14in) in diameter, in the centre and dries it out with the warmth of her own body. She lines the chamber with a layer of wax produced from special glands on the underside of her abdomen, then makes a cell to receive the eggs which have developed inside her from

muscorum).

and moss

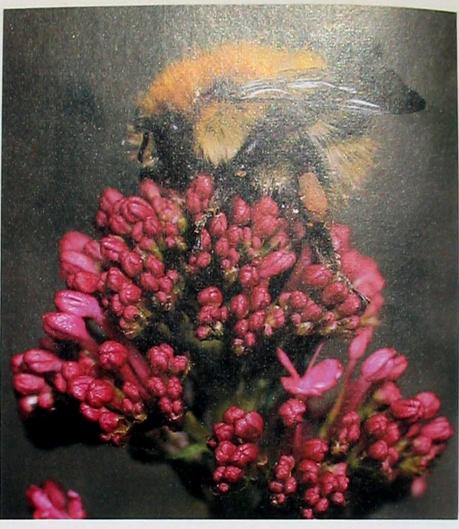
Nests in grass

bee (B.

lucorum)

Makes an

underground



her mating the previous autumn. The cupshaped cell is moulded out of a mixture of wax and pollen and is filled with yet more pollen. Finally the queen lays ten or more eggs inside the cell and seals it with a lid of wax.

The queen bumble bee is a careful and provident mother; she incubates her eggs by sitting on the cell to keep it warm, and also continues to search for food. She brings in more nectar and pollen—the sole food of adult and larvae—than she herself needs and stores them in a specially constructed 'honeypot' made from wax so that her brood will not go short when cold, wet weather confines it to the nest.

Vestal cuckoo

bee (Psithyrus

parasite of the

buff-tailed bee

vestalis). A

Moss carder bee with laden pollen baskets. Bumble bees get their name from their slow bumbling flight; the body looks too heavy for the small wings, but the thrust and lift achieved by the way the wings beat are more than enough to lift the bee and its load. The wings twist on every stroke, are clapped together at the top of the up-stroke, and are then opened rapidly, so creating a vortex which increases the lift on the next down-stroke.

bee (P.

species

rupestris). This

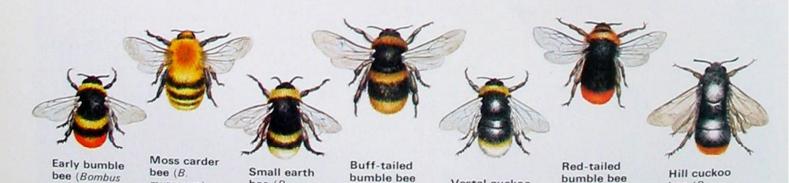
parasitises the

red-tailed bee

(B. lapidarius).

Also called

stone bee



(B. terrestris).

Our largest

species

pratorum). Out

of hibernation

first-late

February



Looking inside a bumble bee nest

The above-ground nest of the common carder bee (Bombus agrorum) is lined with wax to keep out the damp, and completely surrounded with a cover of moss and grass skilfully plaited or 'carded' together. The queen leaves a flight hole open so that she, and later on her workers, can come and go with ease. This nest has been opened to show the interior: the brown (wax-covered) cells contain larvae while the yellow (silk-covered) ones hold pupae. At the bottom of the picture there are a couple of wax 'honey pots' which are used to store food to tide the colony over when it's too cold and wet for the workers to go out.

The growing colony The larvae—which look like white grubs-hatch in about five days and feed on the pollen provided in their cell. The queen replenishes the cell at intervals with regurgitated nectar and pollen and the larvae grow quickly on the rich diet. They moult several times, then spin silken cocoons around themselves and pupate inside them. At this stage, the queen removes the wax round the cocoons and uses it to build new cells. After about two weeks the very small adults-all unfertilized, subordinate females-gnaw their way out of the cocoons. They are the workers whose job in life is to keep the queen and her growing colony supplied with food and to defend the nest and assist with cell-building. They never mate but they can lay eggs which, since they are not fertilized, produce only males (drones).

While the workers forage, the queen stays in the nest, building new cells and laying more eggs. Eventually a colony of up to several hundred workers may develop. The cluster of cells—the comb—is rarely larger than the palm of a man's hand; as the food supply increases and the nest is enlarged, the workers also increase in size.

Towards the end of summer, the queen lays a number of unfertilized eggs which develop into drones; their sole task is to mate with the queens—they never work. At the same time, the fertilized eggs the queen lays develop not into workers but into new queens—up to 200 in large nests. These larvae are fed by numerous workers and receive an abundance of food; it is this level of nutrition which determines whether fertilized eggs become workers or queens.

In late summer the young queens and drones disperse to find mates from other colonies. By late autumn the old queen, workers and drones have all died and only the young fertilized queens go into hibernation.

Collecting food Neither queen nor worker bumble bee needs to be taught how to go about gathering food; they instinctively know what to look for. Their long tongues enable them to reach the nectar stored deep inside long-throated flowers such as foxglove and white dead-nettle, while the hairs on their bodies brush masses of pollen from the flower stamens. You can sometimes see bumble bees almost completely covered in a dusting of pollen. The pollen is held by special storage 'baskets' on the bee's back legs-some bees are known to have carried up to 60% of their own weight in pollen, but a more usual load is 20%. The humming or buzzing you can hear as the bees fly from flower to flower is produced by the vibration of the wings which beat incredibly fast, at a rate of 130 to 240 beats per second according to the size of the bee (smaller bees have faster wing beats). The workers, which usually live for several weeks, go out to forage every day except when it is cold and rainy.

Cuckoo bees

Bumble bees are parasitised by cuckoo bees which look like their hosts but are less hairy and have no pollen baskets. The female cuckoo bee invades the nest, kills the queen, then lays her own eggs. These are cared for by the workers and develop into queens and drones (never workers) which are unable to collect pollen. Alien drones die in autumn, but the fertilized queens hibernate until the next spring when they emerge to take over another bumble bee nest.





the proboscis is folded into a groove under the head when the bee is not feeding



the proboscis is composed of several moveable parts enclosing the hairy tongue (the glossa)

To drink nectar, the bee brings forward its proboscis and alternately shortens and lengthens its tongue. Nectar is drawn up by capillary action through a deep channel enclosed by the hairs on the tongue and passes to the honey stomach, where it is stored until the bee returns to its nest.

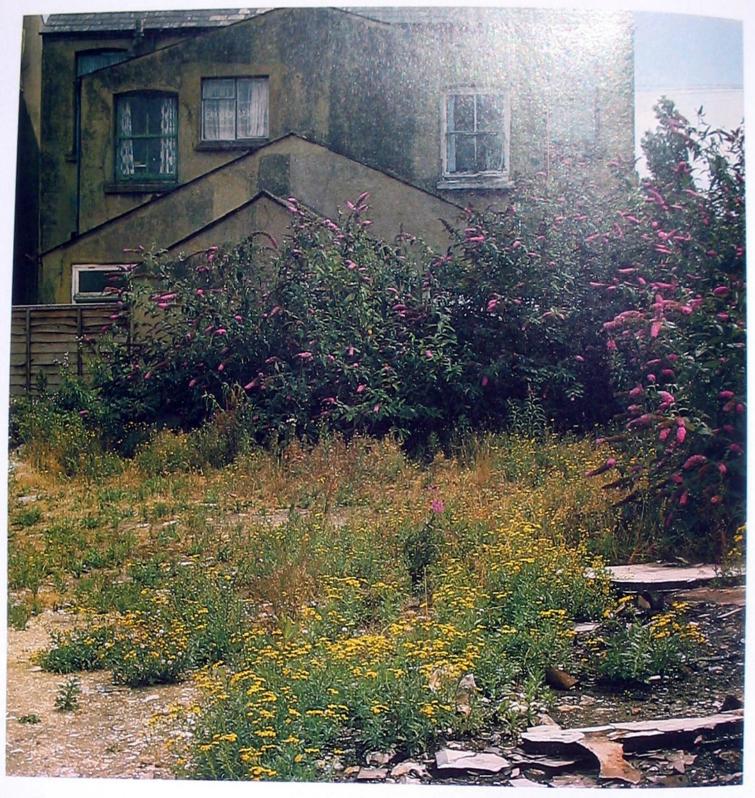
Collecting pollen



back view of hind leg



front view of hind leg The female bumble bee and honey bee (but not the cuckoo bee) collect pollen to take back to the nest. Using her front and middle legs, a bee brushes pollen off the hairs on her head and front part of her body forwards to her mouth. She moistens the pollen with nectar and then passes it to the pollen brush on one hind leg and finally to the pollen basket of the opposite hind leg. It is then pressed into position and held in the basket by the fringe of long, curved hairs.



LIFE IN THE CONCRETE JUNGLE

Nature's resilience and ability to adapt are nowhere clearer illustrated than in the heart of our towns and cities, where many species have taken advantage of added warmth and food supplies to survive and thrive in the seemingly barren wastes of concrete.

It is only in recent years that students of plant and animal ecology have turned their attention seriously to a habitat that now occupies an increasing amount of the landscape and accommodates over three-quarters of our population—the urban environment. The heart of the city, a maze of roads, pavements, walls and buildings, is of special interest since its very artificiality would seem to offer one of the last frontiers to living organisms. Most of the soil lies compacted beneath an almost unbroken blanket of concrete and asphalt; fumes from cars and factories pollute the air, blocking out sunlight and coating surfaces with grime.

Some life forms, like most lichens and

Left: This patch of urban wasteground has been speedily colonised by Oxford ragwort, rosebay willowherb and buddleia. Butterflies and other insects feed on the flowers in summer and mice will almost certainly be sheltering in the rubble.

Below: Many cats in towns are feral ('gone wild'). They feed on scraps left out by residents and supplement this diet with rats and mice. Colonies of 30–40 have been found in big factories, hospitals and town squares. Like starlings, they are quick to locate warm spots, often rearing their litters in hot-air ducts.

conifers, simply cannot survive such conditions. Nevertheless the spread of urban man has been doggedly followed by a motley crew of opportunist plants and animals, all of which have found in the city some compensating feature. Unlike a recently bared patch of ground which is systematically colonised stage by stage by different plant species, development of this urban community contains a strong element of the novel and the unforeseen; conditions may alter with dramatic speed to extinguish some colonist or favour a newcomer.

Plants in strange places Annuals, with their speedy growth and prodigious powers of dispersal, are ideally suited to the fleeting opportunity such as is offered by a building site; typical examples are groundsel and Oxford ragwort. The ability to flourish in nooks and crannies favours ivy-leaved toadflax; ferns and mosses can grow on walls, along with several escapes from garden rockeries. Few plants can withstand the bustle of feet on the pavement, but plantain's low profile allows it to survive in cracks between the slabs. Here, also, dandelion and dock extend long tap roots to counter the problem of a soil which is shielded from the rain by concrete. Trees, with deeper root systems, are better off but can suffer badly in drought years.

Because cities are human community centres, often on a cosmopolitan scale, their



This two-spot ladybird (Adalia bipunctata) is an unusual product of polluted towns. Normally this species has black spots on a red background but some have been found with red spots on a black background. The black form seems to be more tolerant of polluted atmospheres than the red.



plant communities can contain an exotic element. Some, like sorghum and millet, are aliens from tropical shipments, spilled in quiet corners of dockyards and railway sidings. From the cleaned-out bird cage may spring hemp, canary grasses and sunflowers. Apart from beans traced to the leftovers from a Chinese restaurant, the Far East has given city wasteland one of its most rampant shrubs—buddleia. Introduced from China in 1896, it quickly proved nutritious to insects, attracting up to 20 butterfly species to its flowers, aphids to its leaves and ladybirds to feed on the aphids.

Adapting to pollution The two-spot ladybird belongs to a select group of insects that exhibit 'industrial melanism'. In areas polluted with coal smoke, black (or melanic) forms with two or more red spots are more common than the well-known ladybird-red with black spots-that you find in clean air environments. The peppered and pale brindled beauty moths develop darker forms which camouflage them, when they settle on soot-coated tree trunks, against bird predators. Ladybirds do not need camouflage since predators find them distasteful and usually avoid them. The reason ladybirds have a melanic form is therefore probably because this form is less susceptible to some toxin in the smoke and has replaced the red form.

With smokeless zones and cleaner air, melanic forms have become rarer, while insect life has generally increased. It is the constant revelation of cities, therefore, that even the most disruptive conditions seem to favour at least one plant or animal and allow it to gain a foothold.

Bomb-site rubble The World War II blitz of London created in bomb-sites a completely new habitat almost overnight. At first glance these heaps of rubble and ruined walls were not too promising, but a few species were astonishingly quick to take advantage of the pockets of exposed soil. As if from nowhere, rosebay willowherb (also called fireweed) appeared to spread a carpet of shining mauve over the ashes, creating a great well of nectar to attract, in turn, elephant hawkmoths, quite alien to most Londoners and large enough to intimidate many of them. The black redstart, until then a vagrant bird from Europe, discovered in the crumbling masonry an ideal hole-nesting habitat and started breeding.

As the bomb-sites were cleared and built upon, many associated species retreated; willowherb, however, remains common in these areas and the odd redstart still breeds at power stations and gasworks. The kestrel, which was numerous in cities after World War II, also used bomb sites to prey on rodents. But partly because the sites were cleared and partly because many of the kestrels were killed by eating prey that contained toxic chemicals, this species of bird became scarce in inner London in the late 1950s and early 1960s.

Nesting on concrete Many birds show remarkable versatility in the way they use concrete buildings. Pigeons are, of course, the best known city colonizers, finding rooftops and window ledges perfect substitutes for the cliffs and rocky caves they use in the wild. At the turn of the century, starlings discovered that Victorian gothic architecture, with its sheer walls and ornamental ledges, represented an ideal dormitory. Thereafter, urban roosting spread at a remarkable rate, the starlings foraging up to 20 miles outside big city centres and swarming in at night. Today, one of the largest roosts is in central Glasgow which, in winter, nightly plays host to upwards of 250,000 squabbling birds.

In coastal towns seabirds such as fulmars, herring gulls and kittiwakes emulate pigeons and will use rooftops and ledges for nesting. One riverside warehouse at North Shields, in Tyne and Wear, supports a breeding colony of over 100 pairs of kittiwakes on its window-

Right: An enterprising urban coot has made use of bits of biscuit wrappings, cardboard and crisp bags to line its twig-based nest.



Below: Gulls nesting on roof tops instead of cliff ledges are now quite a familiar sight in towns, particularly coastal ones such as Whitby in Yorkshire. sills. A large number of gulls have also become town dwellers: before 1940 it was rare to see a gull nesting on a roof top, but by 1977 some 7000 pairs were roof-nesters.

Warmth in winter Another attraction of the city for all birds is the distinctive urban climate; London, for example, is on average a degree or two warmer and somewhat drier than its hinterland, an obvious bonus on long winter nights. The brick and concrete buildings retain a considerable amount of warmth from heating systems. Warm ventilator shafts and cooling towers make coveted roost sites. In fact the city can be a much better choice in winter than the surrounding countryside. In the winter of 1968, for example, after three weeks of snow London's blackbirds weighed 140g (5oz), but woodland blackbirds weighed only 80g (3oz). Clearly the city populations were able to find sufficient food.

Cities also cause some curious side-effects in some of their wildlife inhabitants: dozing birds, mistaking the numerous street lights for daylight, not uncommonly burst into song in the dead of night. Trees are also confused by the artificially long day, and often leaf in winter.

Predators on the prowl For birds, cities offer less risk of predation from animals such as weasels and stoats. However, the centre is by no means devoid of predators. Kestrels. for example, have returned to many city centres to prey on sparrows. There has been a remarkable spread of foxes into urban areas in recent years, making one of our traditionally wildest animals a well-established feature of many large towns and cities. Several fox families have been recorded living well within reach of the centre of Birmingham. In London, where the fox population is still growing, cubs have been born only 3 miles from the heart of the city, and in autumn and winter, when foxes generally range further afield, some make forays into the very centre.





The croaking of the male frog in the breeding season is a guiding call to any females in the area, and helps direct them to the spawning site. It also signals the preliminary stages of courtship with the female, which only grunts in response.



When the frog is swimming, its pale underside helps to camouflage it against light filtering down through the water. If the frog had a dark belly it would be outlined against the light and therefore easily spotted by underwater predators.

CROAKING FOR THEIR MATES

The mating ritual of frogs is a spectacle of sexual frenzy deserving an 'X' certificate, as males scramble on the back of any available female and hold on for up to 24 hours.

The common frog is present throughout Britain and Ireland, except for the Outer Hebrides and Orkney, and has an extensive range of habitat-from sea level to nearly as high as the snow line on mountains 760m (2500ft) up. Its usual habitat is damp vegetation and near water and it is often a visitor to suburban gardens.

The frog is not the easiest creature to spot since it spends most of its time sitting among thick vegetation, where it is well camouflaged. Your best chance of seeing one is by disturbing it—although you will have to be on the alert, because at the first sign of danger it is off with a couple of startled leaps into nearby foliage.

Colour and markings The shade and marking of the common frog's skin vary enormously. The basic colour ranges from a pale greenish-grey, through bright vellow to a dark olive-coloured brown. The skin can be marked with spots, speckles or marbling in black, brown or red; in Scotland large, reddish-coloured frogs are quite common. The only regular markings are the dark cross bars on the limbs, and streaks behind and in front of the eyes. When the frog crouches the dark bars on the thighs, calves and feet are aligned to form continuous dark streaks. These and other patterns break up the frog's outline and help it to merge into the background.

The frog can also change its colour, lightening or darkening its skin by contracting or spreading dark pigment cells scattered over its body beneath the outer skin. The basic pattern remains the same, but within an hour the frog can assume a completely different colour. In lighter, warmer and drier conditions it becomes paler, but darkens when in colder and damper weather.

The skin is smooth in texture with numerous small bumps on the flanks. The only exception occurs when the female develops a rough skin texture in the spawning season, which enables the male to distinguish the sex. Special mucous glands in the skin keep it moist, so the frog can breathe through its skin and supplement the respiration of its



Left: The frog's large protruding eyes are a distinctive feature. The pupils can contract to a horizontal slit in bright light, but the eyes can only be closed completely when the frog withdraws the eyeballs into its head, which it does when eating.

simple lungs. The skin can also absorb water, so the frog does not need to drink. As it grows, the frog regularly sheds a transparent surface layer of dead skin (because dead skin cannot stretch as the frog grows). Just before this happens, the mucous glands become very active, lubricating the new skin underneath. When the surface of the skin starts to split, the frog uses its feet to push off the old covering, which it generally eats afterwards.

Eves and mouth One of the most distinctive features of the frog is its large jewel-like eyes. The glistening iris is brown, flecked with gold, and the limpid, large round pupil contracts in bright light to a horizontal slit. Each protruding eye is protected by a thick immovable upper and lower lid and a thin movable transparent inner eyelid which is known as the nictitating membrane. This can be raised from beneath the lower lid to cover the eye, especially when the frog is underwater. The only way the frog can close its eyes so that the upper and lower lids meet is to withdraw the eyeballs into its head. It does this when swallowing food, gulping and blinking at the same time; pressure from the back of the eyeballs helps force food down the frog's gullet.

The frog makes good use of its wide mouth and long tongue to snap up whole invertebrates. Slugs and worms are a favourite diet, but the frog also catches flies and insects which might be expected to escape such a sedentary creature. The free end of the tongue, which points down the throat, can be projected with a whiplash action at great speed to snatch unsuspecting prey nearby. The frog has numerous, minute cone teeth around the edge of its jaw and two patches of teeth—vomerine teeth—in the roof of its mouth; these prevent slippery slugs, snails and worms from escaping once caught in the frog's mouth.

Breeding cycle Frogs are not usually seen

until February or March, when the adults emerge from their winter retreats-ponds, ditches and occasionally on dry land. They now begin to congregate at various breeding sites, preferring ponds that have water flowing in and out of them, and canals. Frogs may travel a distance of half a mile to reach their spawning site, where they gather together in large numbers particularly on mild rainy nights-an amazing spectacle. The males, who always arrive first, strike up a croaking chorus-a 'grook-grook-grook' call to attract the females. They produce this mating call by closing the mouth and nostrils firmly and gulping air backwards and forwards over the vocal chords. Frogs can amplify their croaking by puffing out their throat pouch with the internal vocal sac. The female frog only utters the odd grunt; she is never as vociferous as the male.

Free-for-all mating Frogs do not display any elegant courtship rituals; the eager male simply grabs the nearest female as she arrives at the spawning site. So strong is the sexual urge that the male in his frenzy may even grab another male, a fish, a stick or, if offered, a human finger. Jumping on the female's back, the male wraps his forelimbs around her body

Catching prey the tongue is joined to the front of the mouth



The frog catches moving prey by flicking out its long tongue. When the food is inside the frog's mouth, it is squashed between the tongue and the eyeballs (which are drawn down inside the head).

Below: Common or grass frog (Rana temporaria) meets common toad (Bufo bufo): the frog is generally slighter, with a maximum size of up to 10cm (toads up to 15cm). Its skin is smoother than that of the more warty toad. In the mating season a male frog may even jump on to a toad's back in the mistaken belief that he has found an ideal mate.



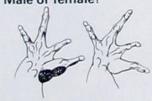
Metamorphosis . . . from egg to frog



Each frog's egg, 2-3mm in diameter, is enclosed in an envelope of jelly. When the egg is deposited into water the jelly swells to a diameter of 8-10mm, insulating the eggs from the water. The egg develops into a tadpole in 10-21 days (the higher the temperature the shorter the time). The tadpole digests the jelly using a secretion from a special gland, and adhesive organs help attach the tadpole to other spawn or water plants. Until the mouth forms, the tadpole gets nourishment from the remains of the egg yolk. It then starts to eat algae, breathing by means of three pairs of external gills, which are soon covered by a flap of skin. An internal gill cavity is now used for breathing, connected to the outside by a small hole (spiracle) in the left side. Normally hind leg stumps appear after five weeks; by the seventh week toes have formed. At eight weeks lungs have developed and the tadpole surfaces to gulp air. By the twelfth week development is accelerating and the forelimbs are visible. The spiral intestine is shortening in readiness for a carnivorous diet, while the substance of its tail is transferred to the body by a process known as resorption which adds nourishment for more growth. The final stage takes ten weeks and by May/June the young frog, now 12-15mm long, spends most of its time on rocks out of water or in nearby damp grass. Scarcity of food or cold conditions may delay metamorphosis and overwintering tadpoles are not uncommon in the north. Young frogs are 20mm long by October/November and double in size by the following autumn. They reach sexual maturity in the third year.



Male or female?



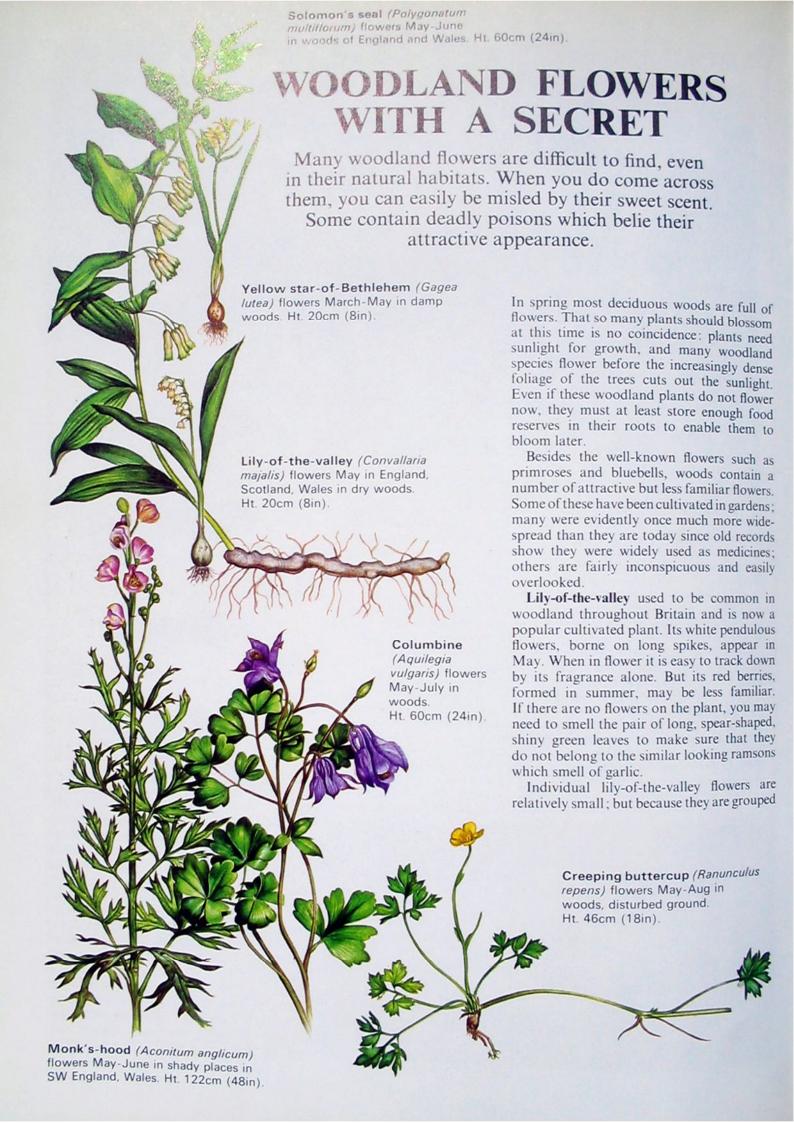
In the breeding season these two swellings (nuptial pads) on the male frog's forelimbs (above left) are covered with a dark, rough layer of skin. just below the 'armpits' and grips using his nuptial pads-a position called amplexus.

The spawning itself, which takes place in water, can happen at any time during amplexus and lasts just a few seconds. The female lays over 2000 black eggs by pressing her forelimbs on her abdomen as the male releases sperm. The eggs are fertilised by the male's sperm immediately they are laid, and before their gelatinous capsules absorb water and swell up. The capsules swell very soon and this reduces their density. So the spawn, which at first sinks to the bottom, floats to the surface, joining up with all the other spawn in one mass.

After spawning, the female normally leaves

the pond while the male often goes in search of another mate. Both male and female frogs return to the same breeding site year after year, probably recognising it by the smell of the water and algae.

Survival Only a few of the masses of tiny frogs survive to adulthood. Most perish or are taken by predators such as herons, gulls, ducks, snakes, hedgehogs, shrews, badgers, rats, weasels, stoats, otters, mink and foxes. Drainage of wetlands, the constant dredging of rivers and the decrease of farm ponds have meant fewer suitable places in which to live. Pollution of the water and the indiscriminate use of insecticides have also affected the frogs' habitat.



into clusters, they are conspicuous to many insects which are also attracted by the strong sweet odour. Insects visit the flowers to collect nectar and carry away and eat the pollen, some of which is transferred to other flowers. Like a number of other plants, lily-of-the-valley can spread vegetatively as well as produce berries. It sends up new shoots from its creeping underground stems, and these form new plants. All parts of this plant contain poison that can be fatal.

Solomon's seal is a relative of the lily-of-thevalley that occurs in woodland. It derives its name from the belief that its white, tangled underground stems represent the Star of David, the two interlinked triangles that were King Solomon's magic symbol for putting

evil spirits to flight.

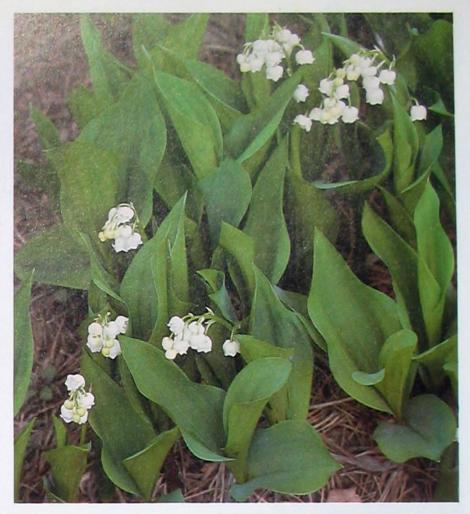
Solomon's seal grows in woods throughout Britain but it is common only in the south. Elsewhere it is often a garden escape. The small bell-shaped flowers, white-tipped with green, droop in small clusters from the gracefully curved stem. The flowers are replaced by blue-black berries that hang either separately or in clusters of up to three from the base of the pairs of broad, stalkless leaves on the upper part of the stem. The lower stem is bare.

The yellow star-of-Bethlehem has dainty pale yellow-green flowers that are somewhat similar to those of the more abundant lesser celandine. The leaves are quite different, however, being narrow, rather like those of the bluebell. It is rare to see large numbers of these plants growing wild as birds such as pheasants eat them if they get the chance.

Monk's-hood is a member of the prolific buttercup family that can be seen in spring. It bears helmeted purple flowers on fairly long spikes and its deeply indented leaves arise alternately from the stem.

The columbine is a particularly beautiful member of the buttercup family which grows in lime-rich soils in damp woods and fens. It gets its name from the Latin word columba, meaning a dove, referring to the structure of the flower. Each drooping dark violet or blue bloom has five spurred petals arranged like doves around a bowl of food, while the sepals resemble wings.





Above: Lily-of-the-valley and creeping buttercup (below left) are both poisonous if eaten in their fresh state. But a little poison, professionally administered, can be beneficial to patients; extracts from lily-of-the-valley have been used to relieve some types of heart disease.

Right: Monk's-hood is another deadly plant. The extract from its roots was in medieval times put on the tip of arrows used when hunting wild animals. Its leaves are easily mistaken for parsley, with disastrous consequences.





The nectaries of the columbine are hidden at the base of the long petals and can be reached only by long-tongued insects, chiefly bumble bees. As the bees drink the nectar, they support themselves by clinging to the sepals and stamens, and so receive pollen on the underside.

The stigmas ripen and grow longer until they project beyond the stamens, so that they are touched first by any visiting insect with a pollen-dusted body. However, not all insects reach the nectar by the proper route. Some bumble bees bite a hole in the base of the flower to reach the nectar. This hole then allows shorter-tongued honeybees and flies to join the feast. The flower can then be pollinated accidentally.

Occasionally pink or white columbine flowers are found. They are almost always a result of the escape from gardens of the familiar cultivated columbine, usually known by its Latin name Aquilegia. All columbines are poisonous.

The greater stitchwort is much more common than any of the flowers described so far. Its white star-shaped flowers form beautiful splashes in woodland and hedgerows in April. The blooms are borne on weak stems that lean for support against other vegetation. In some areas the plant is still referred to as 'dead man's bones' or 'old nick's ribs', folk titles that reflect the brittle nature of the stem.

Stitchwort, as its name suggests, was once thought to cure a stitch—a pain in the side—when it was mixed with powdered acorns and dissolved in wine. Cynics might be forgiven for speculating whether the cure came from the stitchwort or the wine.

The early purple orchid is one of the earliest and most abundant woodland orchids—and like most orchids, it thrives on soils containing chalk or limestone. The pinkish-purple flowers, borne on spikes, spring from between long leaves which are blotched with purple and black markings. After fertilisation, the orchid's scent changes from vanilla to an odour rather like that of cat's urine. This is thought to dissuade insects from visiting the flowers after pollination.

The early purple orchid is sometimes called 'dead man's fingers' because of the two finger-like tuberous roots where it stores its food. One root is filling up for next year's growth while the other, older one is emptying

to supply present needs.

Helleborines are another group of orchids you will find in woods, especially beech woods. Few other plants can grow here, partly because of the deep shade produced by the canopy of foliage above; but helleborines thrive in these conditions. The white helleborine, which has white scentless flowers, is sometimes known as the poached egg plant because of its small orange-yellow pigmentation within each flower. The narrow-leaved helleborine has pure white flowers and shiny green leaves. It is the rarer of the two plants.



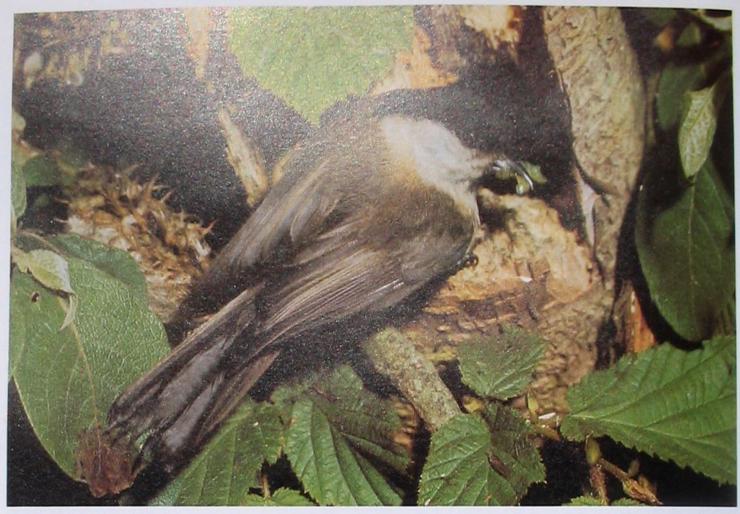
TWO OF A KIND?

Marsh and willow tits are so similar that they were not recognised as distinct species until 1900. Stuffed museum specimens showed the willow tit wasn't a newcomer—it just hadn't been identified before.

The most fascinating thing about marsh and willow tits is the problem of identification. Since the year 1900 when the two species were positively distinguished, much has been found out about the birds and field recognition skills have improved greatly, but the two still present one of the greatest challenges to British bird watchers. It is not too difficult to separate marsh and willow tits from other tits: they are slightly smaller than a blue tit, they are our only two truly black-capped tits (both the great and coal tits have white marks on the crown), and their plumage is a subtle mixture of delicately toning beiges and browns. The problems all start when it comes to deciding which is which.

A ruffled-looking marsh tit feeding a beakful of grubs to its chick. The nesting site in the apple tree probably started out as a natural hole, and was then widened and deepened by another bird before being taken over by marsh tits who almost never excavate.

Marsh tit (Parus palustris); 11cm (4½in) from beak to tail; distribution widespread in dense deciduous woodland up to the borders of Scotland, but absent from Ireland.



Sight and sound The black crown of the willow tit is not as glossy as that of the marsh tit-but this characteristic is influenced by the quality of the light and requires an exceptionally close view, so is risky to rely on. A better guide is the pale patch visible on the closed wing of the willow tit, which is lacking in the marsh tit. This patch is often conspicuous and, if present, is a clear indication that the bird is a willow tit. Unfortunately for bird watchers, damp feathers or the wear and tear caused by the bird scrambling in and out of a nest hole during the hectic summer nesting season can obscure the pale patch, and the lack of it does not necessarily confirm that the bird is a marsh tit.

These differences are so small that it is difficult to identify the birds with any certainty. Fortunately, however, there is another feature which is of great help: the two birds have distinctly different calls, in addition to a variety of sharp notes to keep in contact with each other. Only the marsh tit produces a rather explosive 'pit-chu' sound, and only the willow tit a scraping 'dee-dee-dee' or 'chay-chay' reminiscent of a squeaking gate hinge.

'Marsh' a misnomer The marsh tit is rather inappropriately named as it is the willow tit which shows a preference for swampy woodland and copses. This mix-up probably dates from the days before the two species were separated.

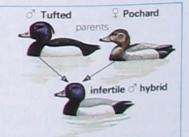
The marsh tit prefers dense deciduous woodland, generally with oak, hornbeam, hazel and beech trees; these produce a prolific and nutritious seed crop which forms a valuable part of the tit's winter diet. Some hibernating insects, plus their eggs and larvae concealed in cracks in rough bark, are eaten in winter, but insect food becomes most important as spring advances. The chicks are often fed almost exclusively on caterpillars—the green winter moth caterpillars which usually occur in enormous numbers in oakwoods are specially favoured. As autumn comes and the supply of insects dwindles, berries start to feature in the marsh tit's daily menu.

Its pale wing patch and bull necked appearance identify this willow tit, which is bringing caterpillars to its young hidden deep inside the nest hole. The strong neck muscles enable the willow tit to excavate a sizeable hole in softwood.

Willow tit (Parus montanus); 11cm (4½in) from beak to tail; distribution widespread in damp deciduous and conifer woodland including lowland Scotland, but absent from Ireland.

What is a species?

A species is a term used to classify similar looking individuals that can only breed successfully with others of their own kind. This means that offspring retain the particular characteristics of their parents which fit them to their special place in the complex web of life. Similarities in appearance, calls, song and behaviour



patterns and courtship rituals help individuals to recognise others of the same species, differences in these things keep species apart: for instance, though willow and marsh tits look extremely similar, they do not interbreed. However, since nature is versatile, there are exceptions. Two different species of duck can mate, but their offspring—hybrids—are usually infertile. Individual varieties can exist within a species—hence the different colours of pigeons—and these varieties can breed together successfully.

In winter marsh tits may join any large mixed flock of tits that moves through their area, but this is only on a temporary basis and they will not move far, deserting the flock as it passes on. It seems probable that many pairs remain in the same territory, winter and summer alike. The territory is large compared with that held by other tits, and sometimes exceeds 10 acres in extent. It is noisily and fiercely defended by the male throughout spring and summer.

Pairing takes place in February and March when the territory has been established by the male, and the search for a nesting site then begins. Competition for a suitable nest site is intense between all the tits; the marsh tit can hold its own against blue tits but will usually give way to great tits. The squabbling over nest sites is accompanied by a lot of aggressive calling, and even by fighting.

Marsh tits choose a natural hole or crevice, usually in a tree or where a branch has broken off, but occasionally in a bank or wall. Sometimes they take over a second-hand nest hole of another species, and chip away the wood to modify the entrance, but they will only very rarely excavate their own nest in rotten timber. The nest cavity is floored with moss and usually lined with hair or fur. In April or May five or six white eggs with red spots are laid (up to a dozen may sometimes be produced). The female incubates the eggs for 13 or 14 days, with only brief excursions from the nest for food. After hatching, the young remain in the nest for 15 days before fledging, being fed by their parents for the whole of that time. In cool, damp summers this period may be extended by several days until a settled spell allows the youngsters to emerge with a reasonable chance of learning to fend for themselves within a few days.

Willow tree dweller The willow tit is more aptly named since the willow is one of its favourite nesting trees. Willow tits often breed in damp woodland, usually ones with many old, moss-covered tree stumps. The essential requirement in their breeding area is a supply of live, dying or decaying softwood stumps. Birch and elder are often used for nests, as well as willow.

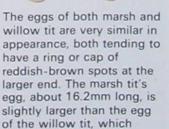
The willow tit pair excavate their nest—a striking difference, not just from marsh tits but also from other British members of the tit family. It is often impossible to separate male from female willow and marsh tits by sight (the female may be very slightly smaller), but studies of colour-ringed birds have shown that the female does most of the excavating work. Unlike woodpeckers, which leave a conspicuous pile of chippings below their nest hole, willow tits usually carry their debris 10 to 15m (11-16yd) away, and for good measure may pulverise it too, leaving no tell-tale traces at the nest.

Excavating naturally demands strong and bulky neck muscles if the beak is to be effectively used as a combined hammer and chisel.



These muscles give the willow tit a distinctly bull-necked appearance which can be one of the best ways of separating willow from marsh tits in the field.

The nest chamber is 20-30cm (8-12in) deep, with a carpet of fine roots, grasses and other fibres supporting a nest cup lined with fur or feathers. Unlike the marsh tit, willow tits very rarely use moss. The willow tit's eggs are very similar to those of the marsh tit but the average clutch is rather larger, at eight or nine eggs. Incubation and fledging times are also similar to those of the marsh tit. Once the chicks have left the nest, it is very difficult to tell parents of either species from the young, although the young may look fluffier.



usually only reaches 15.5mm in length.



THE UNDERGROUND LIFE OF THE MOLE

Moles are the most solitary of mammals, living in their own restricted system of underground tunnels for most of the year and usually ignoring each other. When they do meet, they fight until the weaker mole retreats. This is true of both sexes—the female is just as aggressive and quarrelsome.

The mole was living in Britain 7000 years ago when the land mass was finally separated from Europe—and from Ireland, which the mole never reached—after the last glacial period. At that time lowland Britain was mainly covered with deciduous forest, which was the natural habitat of the mole.

Today the mole is most commonly found in grassland and pasture—a fact largely borne out by the abundance of mole hills, consisting of the soil excavated when burrows are made. However the mole is still present—if harder to

notice—in deciduous woods and forests. Here it has a network of semi-permanent tunnels, which may be used by successive generations over a period of many years. (The author has observed such burrows in constant use in an oak wood near his home for at least 20 years.)

Tunnel food-traps Each mole has its own territory, an area of perhaps 450 square metres (550sq yd), which contains the tunnels in which it lives. The total length of the burrow varies; but in clay, which has a rich supply of insects and worms, it may be be-

The mole surfacing from its burrow system shows its characteristic pink snout, surrounded by sensitive whiskers, and its rich black fur. This fur will lie either way so the mole can move forwards or backwards along a tunnel without jamming its hairs in the burrow wall.

tween 100 and 200 metres (300-650ft). This underground system acts as a huge 'pitfall trap'; the mole feeds by running up and down the burrows picking up the worms, insects and other invertebrates which fall down into it. In deciduous woodland and old pasture, worms are the most important source of food, but huge numbers of insects may also be eaten. One mole's stomach was found to contain nearly 1000 tiny ants.

Territory and numbers Where there is little disturbance and plenty of soil fauna, particularly in woodland, the tunnels are the shortest and the most permanent. Here the mole has little difficulty in finding enough food. There are seldom more than six mole territories, each with a single mole occupant, in a couple of acres-an area which might also support some three tons of worms, which is sufficient food for a much larger population. However, moles also turn up in poor sandy soils like the breckland of East Anglia. Here the food is much less plentiful, and a much longer tunnel system is needed. You will therefore find many more mole hills but far fewer moles in such places.

Although the mole leads a solitary life, usually within its limited territory, it also seems to have a shared or communal tunnel—a main run—where it is possible to catch a different mole every day for a week or more. Observations suggest that some territories may be more attractive than others; when the mole occupying the most desirable area is removed, another will replace it—and then itself be caught.

Nests Every mole has one or more nests connecting with the tunnels. The nest is usually the shape of a rugby ball, about 20cm (8in) in length. It is lined with dry grass or dead leaves. The mole surfaces to collect such vegetation, although whether more so in daylight or at night time is debatable. It does come out of its burrow more frequently than is often realised, although it is hard to observe since it moves stealthily in long grass. In very dry weather its tunnels may not produce sufficient food, and this will encourage the mole to seek prey elsewhere. As a rule a mole's above-ground foraging is only for a short period; it soon disappears underground to its original burrow. If there is not enough food, a mole may sometimes abandon one area and move on to set up home after travelling for several hundred metres.

Mating, but not matey The cosy, friendly animal described so charmingly in *The Wind in the Willows* is in stark contrast to the antisocial and aggressive individual found in nature. The only vestige of social life is seen in early spring, when the sexes come together briefly to mate. Normally, when a male mole meets a female mole, they fight; however, in February the male may leave his home burrow and set out to find a female. Often when he enters her burrow he is rudely repulsed. Occasionally the female is receptive and

briefly accepts the attentions of the male; he, in turn temporarily loses his aggressive instincts. The animals only remain together for a brief period, possibly a few hours, and then the male departs, often returning to his original territory. This might not appear a very efficient way to ensure successful breeding, but in fact it is very rare to find a female which is not pregnant by late spring.

Early life At birth the young are pink, naked and helpless. They are suckled by their mother for up to four weeks, during which period they grow rapidly, develop their characteristic fur and reach half their adult weight. They soon begin to take solid foodchewed-up worms brought by the motherand to explore the burrows near the nest. After about six weeks they are able to support themselves, and then the family breaks up for good. The young and the mother have by now become less tolerant of each other, and it seems likely that the parent, becoming tired by her maternal duties, drives her offspring away when they can be expected to be able to look after themselves.

For some weeks after leaving the mother, young moles spend a lot of time moving above ground. During this period many are attacked by predators, especially birds of prey, and during the early summer the pellets of tawny owls frequently contain mole bones. It is not uncommon either to find squashed mole corpses on roads. Eventually, however,

Earthworms are the mole's staple diet. Like insects, they are usually caught underground as they fall through the soil into the mole's tunnel. However, since earthworms surface at night, it seems likely that moles come above ground under cover of darkness to catch them. This would also suggest why moles themselves often fall prey to another nocturnal hunter, the tawny owl.



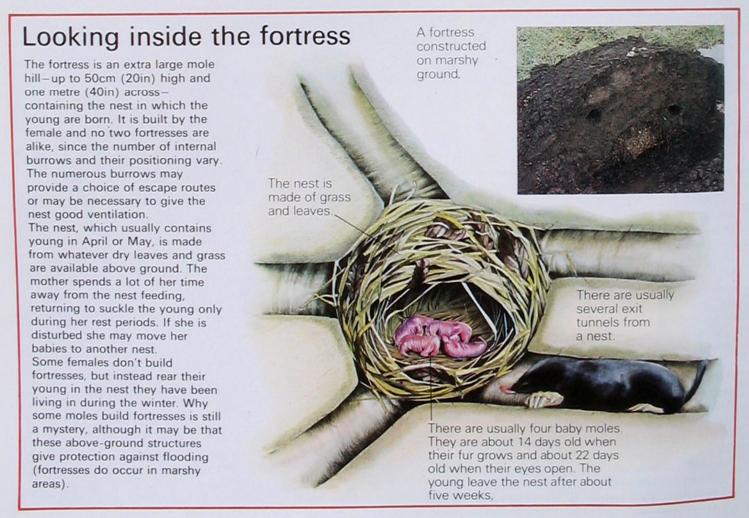


Many mole hills do not always mean many moles. They may indicate that the soil is not rich in invertebrates, so the mole is forced to excavate more extensively to catch enough food. the fortunate survivors resume a subterranean mode of life. Some, particularly in woodland, may be lucky enough to find an untenanted burrow which they take over. The others have to dig in for themselves.

Are moles blind? There is still a lot left to discover about moles—for example, whether or not they are blind. They do have eyes, with all the parts of the normal mammal eye—a lens, iris and a retina; but the optic nerve is poorly developed, with only a fraction of the number of nerve fibres found in, for instance, a mouse or a vole. Some experiments have suggested that moles do respond to light, but it can be argued that the reaction may be due to the nose detecting the heat of

the light source. If you move very slowly and do not create noise and vibration, you can shine a bright electric torch full in the face of a captive animal and get no apparent reaction. The mole behaves very differently, however, if you tap on the surface of the ground quite lightly. If it is eating a worm, it will stop, drop its prey and retreat. It is interesting to note that the species of mole found in southern Europe (*Talpa caeca*) has its eyes covered permanently with a flap of skin and is, as its latin name implies, blind; probably our own mole is almost equally sightless.

Sensors The mole does have well developed senses, so that it is able to live under a wide variety of conditions with evident success. Its hearing is effective if not particularly acute and its quite keen sense of smell can detect a worm at a distance of several centimetres. It has sensitive bristles on its nose and other parts of its body, but it is the naked, pig-like snout which is the mole's most important sense organ. The snout is covered with thousands of minute raised bumps (papillae) which are richly supplied with nerve endings. These receptors are known as Eimer's organs. Their exact purpose and how they work has not been fully investigated, but they appear to detect air movement and vibration. The mole runs up and down its tunnel at a speed of nearly three miles an hour, which for such a small creature corresponds to that of a cantering horse. It would clearly be painful if it







The mole digs through the soil by thrusting its forelimbs sideways and backwards in a breaststroke action. The close-up (above) reveals an almost circular hand with five large, strong claws—powerfully adapted for digging. The result of this digging activity can be seen by the opened mole fortress (left).

ran its nose into the stony wall of the burrow.

Tracking moles Moles are active during the day and at night, and have a characteristic pattern of behaviour. This has been studied with captive moles, whose sleeping and feeding periods have been monitored. Moles have also been studied in the field, where rings of relatively harmless radioactive material have been attached around the base of the tail and the moles, moving underground, have been tracked from the surface with the use of a geiger counter (which detects radiation).

Three days in one Research has shown that the mole fits in three 'mole days' to our oneeven though it is obviously dark all the time underground. The mole spends about four hours sleeping quietly in its nest; it then emerges and moves about its burrow for the next four hours: this makes up a mole's dayand it has three such periods every 24 hours. The mole's activity depends in fact on the food supply. If it finds a few large earthworms, it quickly fills its stomach and does not need to forage for more food. If food is very plentiful, it may collect extra worms, bite off their heads to prevent them burrowing away, and stack them in a small compartment off the side of the burrow, which acts as a larderready to supply food when fresh sources are scarce. If, after four hours searching, the mole has not filled its belly, it retires to sleep, so as not to waste energy, until more food falls

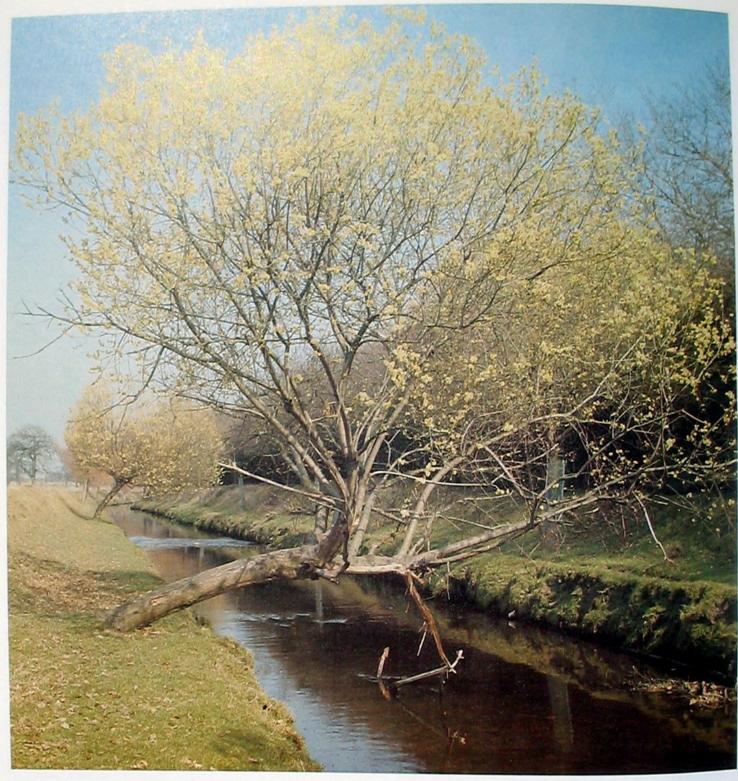
into the burrow system. If after several fruitless periods of searching it is still hungry, it will then either dig some further lengths of burrow in the hope that they will prove more productive, or even come out on the surface and, possibly, move to another location.

Most moles, however, particularly in woodland, find an adequate food supply, and remain throughout the year in their own small restricted territories.

Diminutive mole To anyone whose only knowledge of a mole comes from the mole hills which appear in fields and gardens, the smallness of this mammal will probably come as a surprise if it is spotted or its corpse found. The mole's compact, cylindrical shape is well suited for moving up and down a burrow. Although it appears to have no neck, its bone structure here is similar to that of other mammals. It also has immensely powerful shoulders, which help the forelimbs to dig through the soil. Despite the fact that it spends so much time in the earth, it remains reasonably clean, even in muddy conditions. This is because its fur repels water. When the mole dies, its fur loses this water-resistance; corpses are invariably encrusted with dirt.

A further article on the mole will deal in detail with its digging methods, the amount of earth it can shift and how its specialised anatomy achieves this. The question of whether the mole is a pest or not is also discussed.

MOLE (Talpa europea) Also called mouldwarp or moldewarp ('earth-thrower') Size of adult up to 15cm (6in) long, without tail; weight 80-150g (3-5oz); females slightly smaller Colour black; orange rare Breeding season young born March or April; one litter a year Lifespan average 3 years for those surviving high mortality in first 3 months (few reliable records) Food earthworms, insects: will eat carrion, or in captivity beefsteak and liver Predators man, owls, weasels; domestic cats and dogs kill moles, but seldom eat them Distribution in Britain, except peat bogs, mountains; no moles in Ireland or most Scottish islands



PUSSY WILLOWS

Sprouting in woods, damp hedgerows and by streams, pussy willows are most noticeable for their golden catkins, which are nectar pots for hungry bees.

Pussy willows—or sallows—belong to the willow family, many of which can only grow in waterlogged ground; but sallows grow easily in drier woodland and hedgerows. They are small, rounded-shaped trees, quietly beautiful in a way not appreciated by foresters who, when they find them growing in carefully cultivated plantations, treat them as weeds and cut them down.

Male and female Like all willows, sallows bear their male and female flowers on separate trees. The familiar grey pussy willow catkins are the emerging flowers of the male tree that turn golden yellow as their anthers mature. The female trees have less conspicuous catkins, which do not dangle like those of other Goat willow in the Fens at Easter ablaze with male catkins. In the past bee-keepers used to plant sallows because their abundant nectar was taken by bees to fill honeycombs early in the season.

willows, and become woolly as they mature. Sallows tend to have broader leaves than other willows.

The female catkins are mainly insectpollinated, with bees their chief visitors. When the fruits ripen and split open they discard hundreds of seeds, each one attached to long silver-white hairs that enable them to be blown around the countryside.

There are three species of native sallow. Finds of fossil pollen show that they have thrived in these islands for more than 100,000 years, surviving at least three glaciations.

Goat willow—or great sallow—is the commonest of the sallows; you find it growing on all types of soil, by ponds and streams, in woods and on wasteland. It gets its name because the young spring foliage was fed to goats. The soft, rounded leaves are grey, with whitish downy undersides. It is cut down so often that it rarely has a chance to grow to its full potential height of about 10m (33ft).

Grey willow—or common sallow—is a smaller, bushy tree which grows on limey, as well as acid, soils. Its leaves are narrower than those of the goat willow, harder to the touch and downy on the upper side. The male catkins tend to be more slender, with paler anthers than those of the goat willow, and the tree bears smaller fruit. The Latin name cinerea means ashen or cindery.

The round-eared willow—or wrinkled-leaved sallow—is so called because of the persistent kidney-shaped stipules along the shoots. Its leaves are dull grey-green and wrinkled, with grey downy undersides. It grows as a slight bushy tree or shrub in damp woods, on heaths and moors and beside streams.

Hybrids All three sallows are pussy willows, They interbreed quite easily, so these textbook examples are quite hard to find. Victorian gardeners used to plant a salictum, a collection of willows, but they found it difficult to keep accurate scientific records: so many hybrids were produced that their owners tended to mistake them for completely new species.

Sallow uses From Neolithic times about 5000 years ago to the present day sallows have been used to make coracles—small boats covered with skins—and coarse wattles for fending and fish-traps. Sallow stakes used to be used in fencing and sprouted into hedges; if you push a stick of willow into reasonably moist soil, it will almost certainly grow.

From medieval times taxes were receipted with tallies that were usually made of sallow wood. The tally was split with a knife into two irregular halves. The payee, particularly the Government, kept one half on receipt of payment. When the system was abolished in 1826, thousands of old tallies were fed into the boilér furnace of the House of Commons. It overheated and the building was completely destroyed. Today it has a special use as fine drawing charcoal.

Looking at the goat willow

Goat willow/Great sallow (Salix caprea) native, deciduous, grows to 10m (33ft). Mainly in damp woods and hedgerows, beside streams and on moors and heaths particularly in E. Anglian fens. Flowers March-April, fruits May.





ovarv

stigmas



THE DISTURBED WORLD UNDER THE PLOUGH

Ploughing, sowing and harvesting mean constant interruption for animals and plants. Some creatures, such as cockchafer grubs, survive in the ground from year to year, but the majority are temporary residents, using the fields as a source of food and, once the crops have sprung up, shelter.

Arable land is used for growing crops and, by definition, is regularly ploughed, although ploughing may not take place every year. As such it is a highly artificial, man-made habitat dominated of course by the planted crops from which some animals and birds profit. However modern farming methods, pesticides and weedkillers are changing the balance.

Approximately one third of the surface of the British Isles is covered by arable land, the bulk of it lying on the eastern side of the country. The climate here is drier than in the west-less than 60cm (25in) of rain per year in many parts of East Anglia, compared with more than 100cm (40in) per year for most of Wales-and the land is more easily ploughed. The relatively sunny summers of the eastern regions are also ideal for the ripening of cereals, which are the most widespread and important of the arable crops. The wetter climate and milder winters of western Britain and most of Ireland is conducive to roundthe-year grass growth and the land carries a high proportion of permanent grass in the form of grazing pastures, which rarely or never see the plough.

Crop rotation Arable farming was traditionally based on the rotation of crops, with no field carrying the same crop in successive years. The main advantages of such a system are that pests do not get a chance to build up from year to year and the soil minerals are less quickly exhausted because different crops take different proportions of minerals. Some crops, primarily the clovers and other legumes such as peas and beans, actually put nitrates back into the soil through the action of bacteria in their roots. Despite the advantages of crop rotation, however, there is today a tendency to specialise in just a few crops. Some farmers now grow nothing but cereals, with perhaps just an occasional legume crop to help soil fertility. This method of farming is known as 'monoculture'. Administration and machinery costs are reduced, but there is extra expenditure in chemicals to keep the pests under control and to maintain the fertility of the soil. The majority of farmers spray their fields carefully. Spraying at the wrong time (for example in windy weather) or in the wrong place could kill off large numbers of bees, butterflies and beetles.

Preparing the soil Whenever possible, the farmers like to get their ploughing done in the autumn, as soon as the previous crop is harvested. Recently there has been a marked trend towards winter sowing of crops such as wheat or barley rather than spring sowing. The yields are usually higher and there is greater resistance to pests such as thrips, aphids and wireworms, diseases and drought because by spring and early summer the shoots are already well-established. Where crops such as sugar beet are lifted late, or when the autumn is very wet, it is not possible to get the soil into condition for autumn sowing, but ploughing is still worthwhile if the ground is not too wet. The winter frosts can then get to work to break up the clods, and spring harrowing soon produces a fine tilth for seed-sowing.

Rolling in the seed is a common springtime operation, especially on the lighter soils; autumn-sown cereals are also usually rolled in the spring. The roller breaks the







Above: In early summer the cereal crops are still green. Tractor lines are visible in the foreground where the machines have been used for spraying fertilizers or weedkillers.

Left: Root crops, such as this sugar beet, account for about 15% of our arable land. The harvesters cut off the tops (which are used as animal fodder) and then lift the white tapered roots, from which sugar is extracted.

young shoots, but new side shoots quickly appear and a plant which may have had one or two shoots initially may end up with five or six, each of which will produce an ear of grain. Most crops are also sprayed with fertilisers and selective weedkillers in springsometimes from the air, but more often with tractor-operated spraying machines. Even potatoes and sugar beet, which used to be hoed by hand and by tractor, are sprayed with chemicals.

Artificial habitat Arable land is clearly a very artificial and highly disturbed community—or, more accurately, a collection of communities. Weeds are the most visible colonizers, many of them actually appearing in the fields before the crops show through the soil; if no control measures are taken, they can completely swamp the crops. More than 200 species of wild plants have been recorded on arable land, most of them annuals. Their seeds germinate in spring and the new plants flower and set their own seeds before harvest.

Some species actually produce two or more generations during the summer. The seeds survive the plough and produce a new crop of weeds in the following spring. These annual weeds are rarely found in permanent pastures because they need bare ground in which to establish themselves.

War on weeds Common annuals found on arable land include poppies, scarlet pimpernel, fumitory, fat hen, charlock and scentless mayweed. Herbicides can be used to kill off all these weeds and today's fields are far less weedy than those of earlier times; but new weed crops still spring up every year. Some of the seeds blow in from elsewhere; others arrive as impurities in the crop seed, although this is a far less common occurrence than it used to be because the seed is carefully screened. Corncockle and cornflower, for example, used to be common cornfield flowers; their seeds, larger than those of many other weeds, were returned to the soil with the cereal seeds the next year. Because of



Above: Long lines of poppies have sprung up across fields in recent years after the laying of new gas pipes. This is because their seeds, buried deep in the soil, have been brought to the surface by the mechanical diggers.

Right: This skylark is not feeding the young, despite their gaping mouths: it is removing a faecal sac containing their droppings. It will deposit the white sac away from the nest so as not to draw predators' attention to the young.

their efficient screening they are now rarely seen.

Most of the annual weeds come from seeds which have been buried in the soil and which are brought to the surface by the plough. The brilliant red poppies are among the best examples. Their seeds can remain dormant for many years, and drifts of poppies often appear after deep ploughing.

Perennial plants cannot normally exist in arable land because they are killed by the annual cultivations. There are, however, some exceptions, most of which have creeping roots or underground stems. The plough chops them into pieces, but each piece can grow into a new plant. Creeping thistle and field bindweed are among the commonest of these weeds, the bindweed often climbing up cereal stems at the edge of the field.

Invaders Like perennial weeds, worms and various soil-dwelling insect grubs, such as leatherjackets and cockchafer larvae, survive in the ground from year to year. However, most animal life moves into the arable fields each year-usually in the spring. The aphids are among the first to go in, having spent the winter as eggs on trees and shrubs in the surrounding hedges and woods. The black bean aphid overwinters mainly on spindle trees; when the eggs hatch early in spring the aphids feed by sucking sap from the buds. They reproduce quickly and soon spread into bean and sugar beet fields. Here they reproduce even more quickly and large colonies soon build up. They are all females and give birth to youngsters without mating. One reason for the rapid population explosion is that all individuals can give birth: another is that, with food surrounding them on every side, the insects can concentrate all their energies on reproduction.

Rose-grain aphids also invade the grain



fields. The fact that they spread from the hedgerows is sometimes used to support the argument for removing hedges, but the hedgerows, of course, also harbour the aphids' enemies in the form of ladybirds and lacewings. These insects soon spread into the fields themselves and normally keep the aphids under control. Just how well the ladybirds do this was shown in the winter of 1978-9 when the extreme cold killed off most of the hibernating ladybirds. The result was an enormous plague of rose-grain aphids towards the end of July.

Birds of the fields Lapwings, rooks and many other birds visit the fields in spring to feed on cockchafer grubs and other soildwelling animals; but few of them actually feed on the growing crops, moving away to other feeding grounds when the plants spring up and hide the soil. One notable exception is the woodpigeon, which feeds largely on the leaves of clovers and brassicas (such as kale, cauliflower and cabbage) in winter and spring and on cereals in spring and early summer. The crops often suffer noticeable damage, however, because the birds feed in large flocks. Pheasants and partridges also eat leaves in spring and can often be seen strutting out of the roadside fields. Both species eat the leaves of peas and cereals, although damage is not great, and the partridge also eats plenty of weed leaves. Whereas pheasants prefer to nest in the shelter of shrubs, the partridge is quite happy to nest among the cereals and other

A characteristic bird of the arable fields is the skylark. This familiar songster can be seen and heard high above the fields at any time of the year, although the song is at its best from February to July. During this period the males establish and defend their territories by rising high above them and pouring out their shrill, warbling songs for several minutes at a stretch.

Nibbling mammals The best known of the mammals associated with arable land in spring is the March hare. Bare patches in the middle of cereal fields are often the result of constant grazing of young plants by hares. Rabbits do similar damage, but normally on the edges of the fields, for rabbits do not like to roam too far from the shelter of woods or hedgerows.

Voles and wood mice make frequent sorties into the fields from the surrounding hedgerows and feed on both crops and small creatures; but they do not really live on the arable land. The real denizen of the cornfields is the delightful harvest mouse, which performs some truly amazing antics on the stalks with the aid of its prehensile tail. Its ballshaped nest, supported by several stalks, was a common sight when the cereals were harvested by hand; but the combines give the animals no time to escape and the harvest mouse is now much less frequent in fields.

The Cockchafer

Also known as the may-bug because the adults are abundant during May, the cockchafer (Melolontha melolontha) is a sturdy beetle about 2.5cm (1in) long. It has hard, brick-red wing cases and large, fan-like antennae. The fat white grubs, permanently curved into a 'C' shape and equipped with strong jaws, inflict severe damage on cereals and other arable crops, and are also pests in hay meadows. The female cockchafer tunnels into the soil to a depth of about 20cm (8in) to lay her eggs, and the grubs soon begin their three or four-year feast of roots. They do relatively little damage during the first year because they are small, but the older grubs have amazing appetites and each can destroy scores of plants. Ploughing in early autumn can reduce the population of cockchafer grubs in the Cockchafer grub soil; then the grubs are fairly near the



Adult cockchafer beetle



surface and large numbers are turned up for the birds to eat. Lapwings, gulls and rooks all enjoy a meal of cockchafer grubs (which are called rook-worms in some places) and have no trouble in digging them out of the soil with their stout beaks. Winter ploughing has less effect on the population because the grubs usually tunnel down below the depth of the plough to avoid the cold. Hay meadows suffer more cockchafer damage than cereals because they are not ploughed each year. The cockchafer grubs pupate at the end of their third or fourth summer, usually about 60cm (2ft) below the soil surface. The adults emerge from the pupae during the winter, but remain underground until late April or May, when they come out to feed on the leaves of many kinds of deciduous trees, often causing severe damage in orchards and woodlands. They are strong fliers and cover considerable distances during their lives. The females usually lay several batches of eggs during the early summer and migrate regularly between the fields where they lay their eggs and the woods where they feed. It is during these journeys, which are mostly undertaken at or soon after dusk, that the beetles suffer heavy casualties as they collide with cars, hitting windscreens and radiator grilles.



The harvest mouse is Britain's smallest rodent. Its diminutive size allows it to climb the cereal stalks and feed on the grains from the cereal heads.

CAMOUFLAGE FOR SURVIVAL

Geometer moths have superbly efficient camouflage colouring; adults, about at the beginning of the year, look like bark, while the caterpillars which hatch in April imitate twigs.

The moths you are likely to come across early in the year, all members of the large Geometridae family, have a special feature in common—the females are flightless and can only crawl feebly about on trees and in the undergrowth. The female spring usher and early moths have only vestigial remnants of wings, while the dotted border has stunted, ragged-looking and quite useless wings; female pale brindled beauty, March and mottled umber moths are devoid of wings and look like six-legged spiders. The females never have any need to fly since the winged males will seek them out by scent when the time comes for mating.

Cryptic camouflage The males are nightflying moths which spend most of the day resting in foliage, or on a branch, post, paling or tree trunk. The 'cryptic' streaks, lines and spots on the wings camouflage the moths perfectly, particularly when the wings are in the closed resting position, and are designed to deceive predators. You may well have to search quite closely to find them. The colouring of the male spring usher, mottled umber and pale brindled beauty varies considerably, and light, dark or mottled individuals can be found; the March moth may appear in a dark, smoky coloured form in parts of the north of England. At night the males are attracted to light, so you may have more luck in seeing them if you leave a

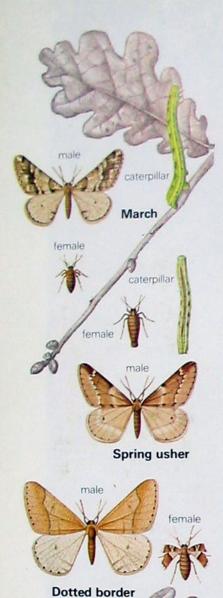
are even more difficult to find since they often hide in a crevice in bark or under leaves.

With the exception of the mottled umber, you can see these moths from the beginning of the year to mid-April. The mottled umber is the odd one out, flying from October through to January or February.

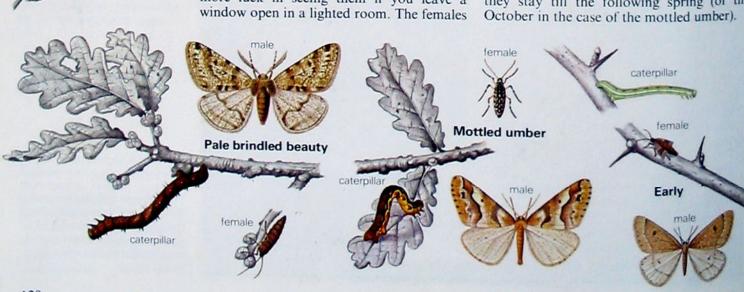
Looper caterpillars Male and female moths mate soon after they have emerged from the chrysalis towards the end of the winter and the females lay their eggs on twigs or in bark crevices soon afterwards. The caterpillars which hatch from the eggs belong to the group known as loopers. They have only two pairs of claspers or false legs (instead of the usual five), situated on the sixth and tenth segments of the abdomen, and move along a twig or leaf by stretching out at full length, securing a firm hold with their true (thoracic) legs, then arching the body and drawing the claspers up in a loop almost to the point held by the thoracic legs. The true legs are then thrust forward and take a firm hold again, in preparation for the next loop. It looks as though the caterpillar is measuring the ground with its body-hence the group name geometer which means ground measurer. The caterpillars often stand upright on their claspers and look like sticks.

Food plants Spring usher caterpillars feed only on oak leaves, but the caterpillars of the other species will feed on hawthorn, birch, sallow, blackthorn and other trees as well as oak. March and mottled umber caterpillars sometimes become so numerous that they reach plague proportions and are largely responsible for the nearly leafless condition of some trees, particularly oak.

Early hibernation The caterpillars feed throughout most of April and May, but in late May or early June they crawl down the tree trunk to the ground (or drop down on a thread of silk) to pupate. The mottled umber, spring usher and early moths pupate in flimsy silk cocoons on the ground surface or in leaf litter under their food plant; the dotted border, March and pale brindled beauty burrow just below the soil. And there they stay till the following spring (or till October in the case of the mottled umber).



caterpillar



FAVOURITE MEADOW FLOWERS

Meadows are the home of some choice wild flowers. Some, like fritillaries, have vanished from most sites, but others, like vetches and medicks, are actually welcomed by farmers.

The traditional English meadow with its profusion of brilliant flowers in spring and early summer was once a much more common sight than it is today. However, permanent and colourful meadows can still be found in Great Britain and Ireland on land that is difficult to cultivate, often with waterlogged or heavy soil, or on ground that is too stony for effective ploughing.

Skilful meadow management is crucial to the survival of wild plants. A meadow on rich soil that is heavily grazed can have vegetation as sparse as if it were on poor upland soil. Similarly if the grass is cut for silage around mid-May, although some wild flowers such as primroses will already have produced their seeds and will have ensured next season's blooms, many other later-flowering plants will be decapitated before this can happen. If meadows are left until July before they are cut or grazed, flowers such as fritillaries and daffodils, moon daisies and orchids have time to shed their seeds and survive from year

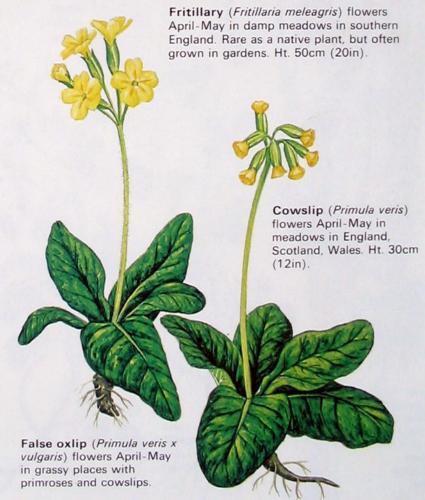
Fritillaries Many old meadows have become casualties of improved methods of drainage and the resulting rich land is now ploughed and cultivated. One casualty of such a practice is the snake's head or fritillary which was introduced into Britain from Europe in the 16th century and used to be quite common in the damp meadows of the

Thames valley.

The plant's rather odd name has quite an interesting origin: in the 16th century, chess and draught pieces were kept in a dice-box which opened out to form the board on which the games were played. In Latin, the universal language of botanists both then and now, a dice box was called a fritillus; because these angular, chequered flowers looked rather like a dice-box the name fritillary was coined for them. Snake's head, another name for the flower, was given in the 19th century perhaps because the flower's mottled markings look rather like scales.

Fritillaries are rare these days, surviving in only a few remaining natural habitats, two of the most famous of which are the meadows behind Magdalen College, Oxford and at





Poet's narcissus (Narcissus majalis) flowers April-May in grassy places. Ht. 50cm (20in).

Stratfield-Saye near Reading. Their dull purplish petals hide the brilliant yellow stamens that are only visible if you lift up their drooping flower heads.

The cowslip is another meadow plant that was once widespread on lime-rich grasslands, but is now less common because of the effects of drainage and ploughing. Its name has a somewhat earthy history, being derived from the Old English cusloppe meaning cow dung; it was thought to grow wherever a cow pat had fallen, perhaps because it tends to occur in scattered clumps in cattle pastures. The name cowslop still persists in some dialects, but the more widespread version has been

used since Shakespeare's time.

False oxlip Although the cowslip flowers rather later than its cousin the primrose, there is some overlap in the flowering seasons. And where they grow together, as often happens, you will commonly find hybrids of the two known as false oxlips. False oxlips are very variable in structure; they usually have flowers that open like those of a primrose, but they grow on a long common stalk (scape) like those of a cowslip. The flowers of the false oxlip do not nod to one side of the scape as those of the true oxlip -a rather rare plant that is found only in old woods in eastern England.

Naturally occurring hybrids like this are uncommon in the plant world-if such events occurred often it would be impossible to

> Spotted medick (Medicago arabica) flowers April-Aug in grassy and waste areas. Ht. 60cm (24in)

distinguish one species from another because there would be so many intermediate types. Occasionally hybrids are fertile and produce seeds, but they are usually sterile and rely on vegetative means to spread themselves. However, hybrids are important in plant breeding.

Poet's narcissus or pheasant's eye is a relative of our wild daffodil, and it was introduced to our meadows from the Mediterranean area. The plant breeder has been able to bring together plants from varied habitats and produce hybrid garden daffodils and narcissi. By fertilising one flower with the pollen from a different one, offspring with new combinations of colour and shape can be obtained. It does not matter if the flowers are sterile because daffodils and narcissi can be multiplied vegetatively by bulbs.

Successful hybrid production comes when the parent species are closely related. You can tell just by looking at a cowslip and a primrose that they have a lot in commontheir leaves and flowers are so similar. What really counts, though, is the chemical makeup of their cells. They must be related genetically to a considerable degree to be sufficiently compatible to produce fertile hybrids that can germinate, grow and flower.

Rich in nitrogen The pea family-the clovers, medicks and vetches-are today important to the farmer as components of his meadow, both for haymaking and grazing. These plants are rich in nitrogen and hence



Black medick is a welcome plant to farmers. It is often sown with a mixture of grasses and clovers to provide rich animal

food.

Salsify (Tragopogon porrifolius) flowers June-Aug in meadows, gardens. Ht. 120cm (48in).

122

Black medick (Medicago lupulina) flowers April-Aug in grassy places. Ht. 50cm (20in).



Field forget-me-not (Myosotis arvensis) -left and below-flowers April-Sept in cultivated ground, beside roads, on dunes. Ht. 30cm (12in).

protein-which is supplied to them by bacteria in special structures on their roots called root

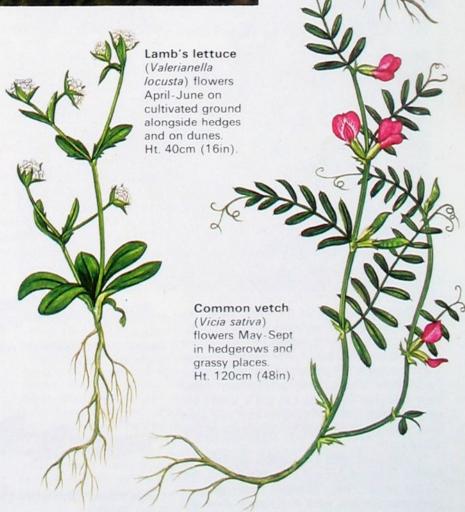
nodules. The medicks have three-lobed leaves like those of clovers-they are often sold to the unsuspecting as shamrock on St Patrick's Day. Spotted medick is less common than black medick and is found more often near the sea. Its seed pods are spirally coiled and prickly, giving the pod its other name, cogseed. The common vetch has seed pods rather like those of our cultivated pea.

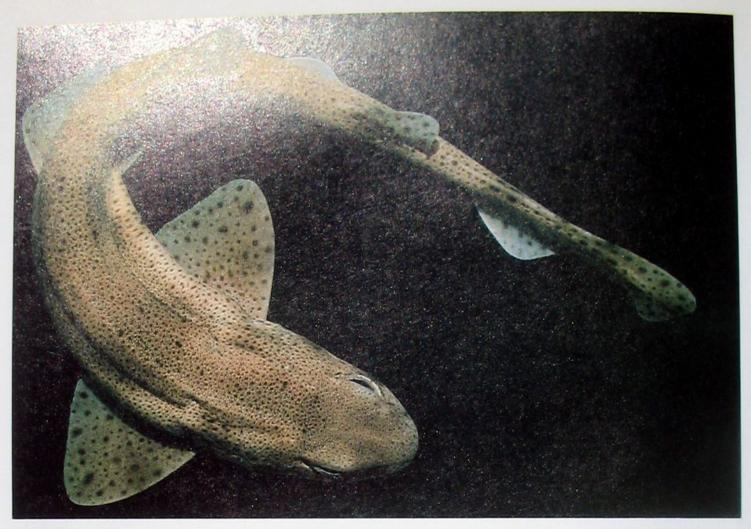
Vetches are scrambling plants, the leaves having twining tendrils at the tip which cling for anchorage to the taller herbage around them. Often grown as a fodder crop, the common vetch frequently escapes to road-

sides and waste places.

Present day meadows tend to be short lived and sown with mixtures of red and white clover and sometimes black medick. All flowers of the pea family have the same basic shape, from the tiny yellow flowers of the medick arranged in clusters to the large solitary flowers of the sweet pea.

Useful species Salsify is now a meadow plant that was originally introduced into gardens from France and Italy around 1700; over the years many plants have escaped and become naturalised. Salsify's long tap roots used to be peeled and boiled, and because of their flavour of salt fish the plant was also called the 'vegetable oyster'.





SHARKS WITHOUT A BITE

There are two species of dogfish in British waters—both harmless members of the shark family. They are perhaps better known as rock salmon on the fishmonger's slab.

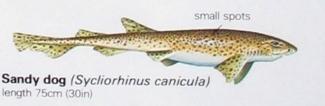
Dogfish do not fit into the popular conception of sharks—fast swimming, white-bellied, surface living hunters of the open sea. However, without going into anatomical details, dogfish do have easily recognisable features in common with all sharks. The skin is covered with fine 'teeth', sharp-edged and all pointing backwards. If you were to run your hand over a dogfish from head to tail it would feel smooth; but rub it the other way and your skin would be scratched by thousands of tiny sharp teeth.

In common with all sharks, dogfish also have a series of 5-7 gill slits along each side of the head. They 'breathe' water through their mouths and emit it through these gill

slits. Many also have a breathing hole behind the eye (spiracle). Their fins have no bony rays but are supported by tough cartilage (gristle) and their entire skeleton is made up of cartilage. Although it is not so rigid, this looks like real bone and is just as hard.

Sharks lack the swimbladder that is a feature of most bony fishes and which helps them to stay buoyant in the water so that they do not waste energy trying to stop themselves sinking. Many sharks compensate for this by having enormously large oil-filled livers which act in exactly the same way as the swimbladder. There is no truth in the claim that sharks have to keep swimming or they would sink to the bottom—their livers help them

The dogfish has a long tapering, flexible body made up of cartilage—a firm elastic gristly tissue also found in sharks, rays and skates. It is a sea-bed scavenger searching even for scraps thrown overboard by passing ships.



nostril groove are

Nostril grooves are connected to the mouth.



underside of head nostril nostril groove

Nostril grooves are not connected to the mouth.

stay afloai. Dochah, however, are essentially bottom-living animals and their livers are

relatively smail

Two species The sandy dog or lesser spotted dogfish, and the nurse hound or larger spotted dogfish are the two species found in British waters. As their names suggest both are spotted; their backs are sandy or grey-brown with dark brown spots and their undersides creamy white. The sandy dog usually has many small brown spots in contrast to the nurse hound which has larger and fewer spots. Unfortunately the size of the spots and general colouration is not an infallible identification guide, because the nurse hound sometimes has numerous small spots as well. Size is a better guide for distinguishing them.

The sandy dog, which is the commoner and more widely distributed, grows to about one metre (39in) in length and weighs up to 6kg (14lb). It lives on sand, fine gravel and even muddy bottoms, and its colouring closely matches the dappled colouring of the sea bed. As an adult it is normally found in depths of 10-55m (33-180ft), but newly hatched young from 10cm (4in) upwards can be caught in

much shallower water.

The nurse hound, the larger of the two species, grows to 1.5m (60in) in length and weighs 9.5kg (21lb). It is found in similar depths to its relative and it tends to live on rough and even rocky seabeds, although it is occasionally caught on sandy bottoms. The young, like those of the sandy dog, are also found in shallow water, but they are larger on hatching—about 16cm (6½in) long.

Egg cases Although most sharks are livebearers, retaining the fertilised eggs within the mother's body until they are fully developed, dogfish lay eggs in egg cases. The females move into shallower water to lay their eggs, which are enclosed in smoothlyrounded, oblong cases with long tendrils at each corner. These tendrils, which tangle up in algae, on rough rock surfaces, on wrecked ships and even on underwater structures such as pier pilings, keep the case safely anchored for the nine months or so it takes for the egg to develop into a young dogfish. Surprisingly, since it is the larger species, the nurse hound lays its eggs in shallower water than the sandy dog; the eggs can even be found at the extreme low tide mark on rocky shores, tangled in the kelp.

Dogfish dinner Dogfish eat a wide range of bottom-living invertebrates, mainly crabs, shrimps, worms and whelks; but they also eat sand eels, gobies, and other fish which live close to the sea bed. They will also scavenge over the sea bed and eat all kinds of odd items, many thrown overboard from ships, including fish heads from trawler's catches.

Dogfish are often sold at fishmongers as 'rock salmon', although the recommended trade name for the fish is 'flake'. They make perfectly good eating; the firm flesh is palatable and has no bones in it.

Born in a case







Dogfish eggs are laid in tough, leathery cases with long curling threads which anchor the cases to seaweeds and often to pier pilings. These threads are so strong that it is rare to find such cases in shoreline jetsam while the eggs are developing. The young dogfish (pups) hatch at lengths of 10-16cm ($4\text{-}6\frac{1}{4}\text{in}$), depending on the species; the cases—also called 'mermaid's purses'—break away and are washed up on the shore where they become black and brittle.

In contrast to bony fishes, dogfish and other sharks produce few, but very large, eggs. The yolk which is not much smaller than that in a hen's egg, will nourish the young dogfish during its long nine month development. At the end of this stage the pup lies with its tail curled over its head, completely filling the case. For a few days after it hatches a small yolk sac can be seen on the pup's belly, supplying it with enough food while it searches for shelter.

THE PRICKLY SUBJECT OF GORSE

So long as you don't touch it, gorse is a particularly appealing shrub. The delicate aroma from its dazzling profusion of golden flowers on warm days, the snapping sound as the seeds burst from their pods later in the season, tempt you to its heathland home. But tread carefully and beware the prickles.

Common gorse (Ulex europaeus) is a member of the pea family. It is native evergreen, grows to 3m (10ft), and is found on heaths, scrubland and grassy places. It flowers most of the year, especially in March-June. Its spines are a special adaptation to dry conditions. If you grow gorse under a large glass jar with plenty of water, it produces well-developed leaves with three leaflets, like its relatives the clovers and lupins.

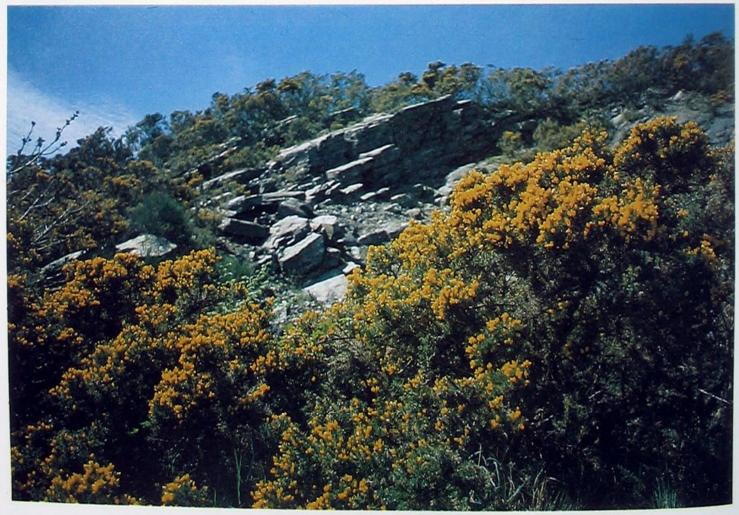
'When gorse is out of bloom, kissing is out of season', according to a traditional English saying. Luckily for lovers, we have three species of gorse in the British Isles, and one of them is always in flower.

The common gorse is a dark-green bush with stout, sharp-spined branches and weaker leaf spines. It is mainly a lowland plant and it often grows among heather and in rough grassy places. Though it seems hardy enough, it is frequently killed back in really severe winters and this allows heather to regain some lost ground.

Gorse-also known as furze or whin-is a pioneer shrub, ie one that rapidly colonises open ground before other plants have established themselves. Gorse leaves are furrowed spines that have a small surface area, so that the minimum amount of water is lost by transpiration—important on the well-drained soils in which it usually grows.

Single gorse flowers may appear at any time from September onwards, even during winter months if the weather is mild enough. But it is in April that the common gorse comes into full bloom, in a good season cloaking the bushes with thousands of glistening golden yellow flowers.

Other gorses The western furze is a stiffspined plant which commonly forms a low scrub of rounded bushes, less than a metre high. These grow mainly on the acid heaths Gorse—a pioneer species—growing prolifically by a roadside quarry at Southwick, Kirkcudbrightshire, in Scotland. Gorse cannot grow in shady places and soon disappears if woods grow up in the same area.



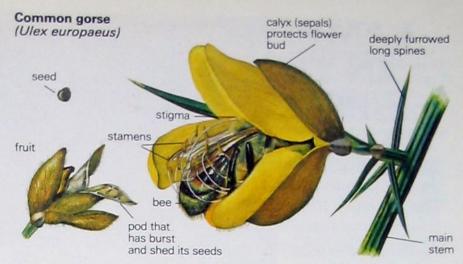


and hill pastures of south-western England and Wales, and Ireland. The dwarf furze thrives on the heathlands of southern and south-western England. It is generally smaller and less prickly than the more widespread western species and it has downy and usually lighter green branches. The flowers are pale yellow, like those of western furze, and appear in late summer and early autumn.

Flowers Gorse has flowers typical of members of the pea family. The petals have a delicate locking mechanism so that when an insect of sufficient weight lands on the bloom, the reproductive organs pop out from inside the flower. The stamens (male) shower the insect's body with pollen. The stigma (female) becomes receptive to pollen on the visiting insect so the process of fertilisation can begin. By this ingenious mechanism gorse flowers are cross-pollinated.

Seed pods The common gorse seed pods dry and burst in July, and those of the two smaller species from July to September. Each pod twists violently as it dries, ejecting the hard, shiny seeds for distances of up to three metres (10ft). Ants are often attracted by the oily seeds and drag them off to their nests. Some seeds are dropped or discarded, explaining the abundance of gorse plants along the sides of footpaths which ants also use as highways.

It is not, however, only gorse seeds that are scattered over the ground, but also the



little grey gorse weevil (Apion ulici). In spring it lays its eggs in young gorse pods. The larvae Western furze consume the seeds and eventually pupate (Ulex gallii) inside the pods. When the adult weevils emerge inside the pods, they do not attempt to bite their way out but remain motionless, covers waiting for the day when the pods burst open two and they can escape.

Food and protection In medieval times gorse was planted to form hedges, which provided shelter near rabbit warrens as well as coverts for foxes and game birds. When food is scarce rabbits, like sheep and goats, manage to extract the tender shoots from between the prickly spines without impaling their tongues. The bushes are often found in the shape of a mushroom, showing the height above the ground that hungry rabbits can reach while standing on their hindlegs.

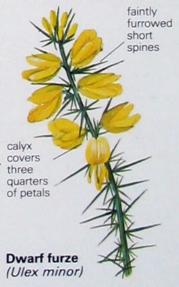
Gorse thorns are ideal for the nests of small birds, including the Dartford warbler, one of Britain's rarest breeding species which is entirely restricted to lowland heaths. Another uncommon bird, the red-backed shrike, frequently nests among the dense thickets of gorse and impales its prey, mainly small birds and insects, on the spines surrounding the nest. Two more common birds found among gorse are the linnet and yellowhammer.

In dry weather, areas covered with gorse are often devastated by fire, sometimes accidentally, often deliberately. (It is an offence to burn gorse without a licence in England and Wales between April and November.) Even when it is burnt down, gorse shows its considerable powers of regeneration and quickly shoots up again from the unburnt stem bases near the surface of the soil.

Gorse can be good for soil. Like the rest of three the pea family, it has bacteria-bearing nod- quarters ules attached to the roots so that it can fix nitrogen from the air to be used ultimately for protein manufacture; this enables it to grow in soils that are low in nitrogen. If the gorse is then removed, the soil is more fertile. Dwarf furze

Uses of gorse Before coal was fully exploited (Ulex minor) and when wood was scarce, gorse was valued as a fuel. It was tied in bundles and used in ovens and kilns. Gorse was also crushed and used as a nutritious winter food for livestock.





IN THE SPRING

Britain is the only industrialised country where sheep numbers are increasing. The lowlands alone are home for over a dozen different breeds and crossbreds.

For the shepherd, or sheep farmer, lambing is the culmination of nearly six months of careful and skilled management. Spring is the time of their annual harvest, when a good crop of lambs is as important to them as a bountiful grain harvest in the autumn is to the arable farmer. To capitalise on the hard work of the previous winter months, the shepherd's one concern is to ensure that lambing goes ahead as smoothly as possible.

As the time of birth approaches, the shepherd rounds up his pregnant ewes and puts them in a field near his home. The site is selected to avoid natural hazards such as deep ditches, ponds or low-lying ground which is liable to flood; the flock must also be protected from exposure to prevailing winds. The need for suitable shelter is important because of the obvious change of environment the lamb experiences when it leaves its mother's body at the moment of birth.

The lamb is ejected very rapidly from the ewe. As the navel cord snaps, the lamb drops to the ground; the ewe gets up almost immediately and investigates her offspring. She begins licking the lamb and massaging it to life; within minutes it is on its feet and searching for her milk-dripping teat.

Most ewes lamb safely without human assistance. A good shepherd will regularly inspect his flock day and night, but only lends a hand when it becomes obvious that the ewe is having difficulties. Otherwise the shepherd's top priority after delivery is to keep the newborn lambs alive. If they are cold and wet, they must be rubbed dry with straw or sacking. More important still is adequate nourishment, since food provides energy and energy generates heat to keep the lambs warm. Ewes and their lambs are therefore penned closely together so that the young have constant access to the udder.

Orphan lambs It is quite common during lambing to find several motherless lambs. This is not so much because ewes die after giving birth, although this does happen, but because certain ewes may be unable or unwilling to accept some lambs. Most ewes have one or two offspring and many are bred to produce twins. Sometimes ewes with twins



may refuse to take the second lamb. Others, through lack of milk or faulty udders, simply cannot look after two lambs. The attentive shepherd will identify these abandoned lambs as quickly as possible and have them fostered.

Ideally the orphans are introduced to a ewe that has lost her own lamb-a delicate operation. The ewe is a sensitive creature. with a keen sense of smell; therefore the orphan lamb's back is rubbed with fluid from the foster mother's cleansing (afterbirth). Another trick of the shepherd is to tie the lamb's forelegs loosely together with string so that it has difficulty getting up. In this way the lamb impersonates the action of a newly born getting to its feet for the first time. Sprays are available which can be squirted over the foster mother's nose to confuse her sense of smell. The lamb is also sprayed and hopefully the ewe will now take to it. If a ewe refuses to suckle her offspring, an effective remedy is to introduce a sheepdog into the pen. The ewe invariably rises to this challenge and defends herself and the lambs.

Survival New-born lambs will put up with cold, wind and snow, but some deaths can be expected if these conditions do occur. Lambs also succumb in large numbers to heavy cold rain. The shepherd can protect his flock against the elements by covering lambs in a plastic coat, which has a large hole for the head and smaller holes for each leg.

Apart from the weather, predators are the other serious threat to the survival of lambs. Although it is popularly believed that foxes are the greatest danger, carrion crows and ravens are even more deadly predators. Raiding parties of ravens have been known to attack when a ewe is in trouble and unable to defend herself.

Stomach worms are another hazard, although drugs are now available which control and eliminate this parasitic problem. In fact in the last 30 years both drugs and vaccines have been of great help to the shepherd. Two small doses of vaccine injected into a lamb will provide protection against eight common sheep diseases.

Lowland sheep Nowadays sheep can be

Above: A few minutes after birth this lamb attempts to get to its feet. It is still covered in its mother's afterbirth.

Below: Perhaps the best dual purpose (meat plus wool) sheep is the Cheviot.



divided into three common groups—lowland, hill and mountain and crossbreds. There is also a category which includes rarer, primitive breeds. Hill and mountain sheep, and rarer breeds, will be dealt with in later articles. Lowland sheep are found throughout the British Isles in the lowlands and are mainly reared for their meat—particularly the production of fat lambs; mutton is now less in demand than it used to be. Wool is the second most important sheep product, although in lowland areas this only accounts for about 15% of the total income from sheep farming. Sheepskin and milk are less important products economically.

Growing populations There are currently about 31 million sheep in the British Isles, more than at any time since official records were first kept in 1866. This total does, however, include lambs which are only present for part of the year. The increase in numbers is interesting because in other industrialised countries the numbers are in fact declining. The popularity of mutton in the past and now lamb as meat, is probably the main reason for this.



The shepherd's year This begins in October or early November when the rams are put to the ewes so that they lamb during March and April. If the area is particularly sheltered or the ewes can be overwintered under cover, some flocks of ewes are mated earlier so that they lamb in February. Lambs sent to market have a live weight of about 30-40kg (65-90lb); when they reach this weight depends on the breed, the feed and the environment. Once the lambs have been weaned and the ewe flock sorted. the rest of the year is spent giving those sheep that are to be kept every opportunity to recover from the stress of lambing in readiness for the next breeding season in the autumn.



Sorrier Laicester Large sheet distinguished by high carriage of head and hold Roman nose (feature imprimed upon offspring). Average lambing rate – 2. Live 84kg (185lb), fleece 4kg (90b).







The sheep of lowland areas of the British Isles are divided into three main groups: the old long or lustre wool sheep, the famous down sheep and crossbreds based on these two strains. Most sheep seen in lowland areas are in fact crossbreds.

Longwool The Border Leicester is one of the great modern breeds, and a fine example

of the longwool type of sheep. This sheep originally came from the border country between England and Scotland, but it is now much in evidence in the lowlands. Its ancestry can be traced to the white-faced sheep introduced by the Romans between AD100 and AD400. This breed is important because its young mature early and fatten quickly and because the rams are used for stud. Sheep breeders now rely increasingly on the Bluefaced Leicester variety (a Border Leicester with some Wensleydale introduced). This is partly because the original Border Leicester was inclined to lose its teeth early, which led to problems of feeding; this fault has now been largely overcome in the Blue-faced Leicester.

The Lincoln sheep looks like the Leicester but grows longer wool. This breed is now comparatively rare in lowland areas, but is widely found in other parts of the world, notably Australia, New Zealand, Eastern Europe and Argentina.

The Romney Marsh sheep remains a native of the region that gives it its name—the bleak, low-lying area in the south-west corner of Kent that is made up of clay and sand and scattered with inlets from the sea. Anyone travelling in this part of England will see many flocks, but they are not widely found elsewhere. They are, however, the most popular and numerous sheep in New Zealand, and their wool is used in the manufacture of quality products including carpets.

The Wensleydale takes its name from the beautiful Yorkshire dale from where it originated. This sheep produces particularly long, curly, lustrous wool, but its main use is crossbreeding. The rams are crossed with Border Leicester ewes to produce Blue-faced Leicesters. Wensleydales are also crossed with the hill breeds to produce the Masham.

Down sheep One of the oldest and most famous breeds of down sheep is the South-down, which is still found throughout the grass-covered chalk hills running along the coasts of Sussex and Kent. The rams were used as studs to improve other flocks in Britain, and many other down sheep owe their development to the infusion of South-



Scottish Half-bred Distinctive white face, more like Cheviot than Border Leicester, from which it is derived. Ewes widely used for producing commercial lambs. Live 78kg (171lb).



Oxford Down Very woolly black face, rather more pointed than other down breeds, Largest of down sheep. Live 89kg (196lb), fleece 3.75kg (8lb).



Southdown Typical down sheep face, with wool well down nose. Compact, hornless, with short, woolly legs, producing finest wool in Britain. Live 57kg (125lb), fleece 2-5kg (5½lb).



Suffolk Down Distinguished by long body, black face and legs, both without wool. Quickly maturing lambs when crossed with other breeds. Live 84kg (185lb), fleece 2.75kg (6lb).

land sheep

Romney Marsh Distinctive, rather coarse wool on forehead. Large, hornless sheep. Live 68kg (150lb), fleece 4kg (9lb).



Lincoln Longwool Broad white face, well covered with curly wool. Largest British sheep. Live 91kg (200lb), fleece 6kg (131lb).



Wensleydale Identified by long curly wool hanging down over blue-grey face. Good lambing rate—2. Early maturing has led to popularity for cross breeding. Live 103kg (227lb), fleece 5.75kg (12½lb).



down blood. These include the Hampshire Down (which crossed with the Cotswold produces the Oxford Down), the Dorset Down, the Shropshire Down and the Suffolk Down. The Suffolk sheep has become the most important breed in this group because, by crossing the ram with the Scottish Half-bred, good lambing rates and meat are produced.

All these down sheep have the same rather square, compact shape and are most distinguishable by the black face (compared with the white face of longwool sheep). The main difference is in the quantity of wool on the face. It is most noticeable on the Hampshire and Dorset, less on the Oxford and largely absent from the Suffolk. It is an odd coincidence of sheep-breeding that sheep without hair on the face appear to give the best lambing yields.

The Dorset Horn is another down sheep having a white face without much wool on it. It is more important than its fellow countryman, the Dorset Down, chiefly because of its capacity to produce lambs at any season. For this reason it is widely used to produce lamb for the Christmas season.

The Cheviot is valuable because it is the best dual-purpose sheep in Britain, producing quality mutton and wool. It is also exported all over the world. It takes its name from the Cheviot hills which cross between England and Scotland. It is now more popular in its so-called North Country Cheviot form, originating from the north of Scotland.

Crossbreds The past 30 years have seen a great development in crossbred sheep—or commercial sheep as they are often called—particularly in chalk and limestone areas. In fact the majority of sheep seen in Britain today are crossbreds. Crossbred ewes that are found in the lowlands are usually a cross between the longwool and a hill breed.

The creation of the Border Leicester (or the Blue-faced Leicester derivative) has given quite a new look to the sheep of Southern England. Before, down sheep usually had a mottled face well covered with wool, while the new Border Leicester crossbred has a distinctive white face without wool and what is termed a Roman nose. The main reason for selectively breeding the Border Leicester so widely is its remarkable capacity for producing twins or even triplets; and lambs bred from it have the advantage of fattening quickly. There are many different crosses, but the most common is achieved by mating a Border Leicester ram with Cheviot ewes; this produces the well known Scottish Half-bred.



Masham Crossbred with distinctive speckled face. Ewes widely used on lowland farms for commercial lamb production. Live 71kgs (156lb), fleece 3·75kg (8lb).



Hampshire Down Well covered with wool, including legs and dark brown face. Live 74kg (163lb), fleece 2-5kg (6lb).



Dorset Down Similar in appearance to Hampshire Down but wool is better. Live 75kg (165lb), fleece 2.5kg (5½lb).



Dorset Horn White-faced; both sexes have curved horns. Poll (hornless) Dorset is also bred. Excellent white wool without black hairs. Unique in breeding lambs throughout year. Live 72kg (158lb), fleece 2.5kg (5½lb).



THE TIRELESS AND TIMELY SWALLOW

Every spring, swallows make an astounding journey from their winter quarters in South Africa. They travel nearly 5000 miles in one month, arriving here in early April to nest and breed and take advantage of our plentiful supply of insects.

Above: Young swallows about to receive a few welcome morsels of food from an assiduous parent. In their nest high up in the corner of an outbuilding, the young are generally fairly safe from predators; the adults warn of the presence of an inquisitive cat (or human) with a series of loud, sharp alarm calls, but use a longer, shriller and more penetrating cry if a bird predator-such as a hobby-appears.

According to the proverb, one swallow doesn't make a summer, but to many people the return of this bird each year is a sure sign that winter is at an end and summer just round the corner. As the weather gradually warms up in spring the flight paths swallows take on their migration journey north from South Africa can be mapped right across Europe. The first swallows appear in southern Britain on or around April 10, but the north of Scotland may have to wait until early May before the breeding birds arrive.

Food supply is the vital factor controlling both arrivals and departures. Swallows feed by catching insects on the wing, and in good weather you can often see them flying low over water meadows or skimming along a river, above a hayfield or even the local cricket pitch. In cold, wet or windy weather they gather in large flocks to concentrate on places where insect food remains available, often down-wind of large bodies of water where insects may be hatching, or in the lee of a wood or hedge where there is shelter. In temperate northern areas such as Britain where the birds breed, the summer supply of food is very good and is fully exploited by the migrants arriving from the south. In winter however there are few if any flying insects and any swallows rash enough to remain would soon starve to death.

A question of identity There are four species of fork-tailed, aerial-feeding birds which come to Britain for the summer months and which, at first glance, may be confused with each other. One, the sooty-black swift with its sickle-shaped wings, is not closely related to the swallow. The other two, the house martin and the sand martin, are members of the same family group as the swallow-the hirundines. The house martin has a patch of white on the back at the base of the tail while the sand martin can be distinguished by its dark brown upper parts and small size. The swallow has a longer and much more deeply forked tail than the other species, and the sleek, burnished blue of its head, collar and back, rusty red chin and pale pinky-brown undersides make it unmistakable.



Left: The angle between rafters in a barn or shed is a favourite nesting place for the swallow, providing a firm base for the cup of mud reinforced with dried grass. A lining of hair and feathers makes a soft bed for eggs.

Swallow (Hirundo rustica), also known as the barn swallow; 19cm (7½in) from beak to tip of tail; distribution widespread throughout the British Isles from spring to autumn.

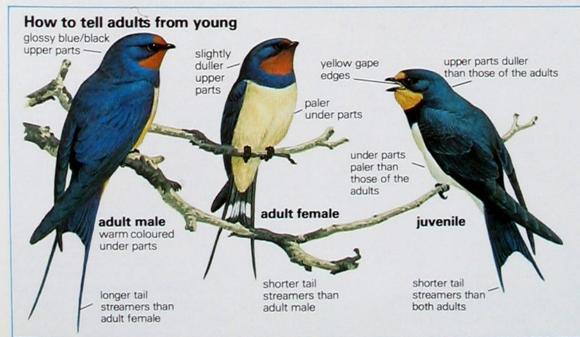
Raising a family The first swallows to arrive—the males—are quick to establish their nesting sites; females arrive soon after. Pairs are formed with aerial display flights, mutual preening and exploration of the chosen site. Swallows show a very positive preference for buildings as breeding places, choosing a variety of barns, sheds, garages and porches. The main body of the nest is made with pellets of wet mud cemented together and is lined with hair and feathers and sometimes dried grasses.

The first clutch of four or five white eggs with reddish markings, laid fairly quickly, is incubated by the female and hatches after 14 or 15 days. The youngsters are fed by both parents for about three weeks, until they fledge, and then for a few days more while they fly around the nest site. After that, the young birds disperse and the adults set about raising a second brood. Some assiduous pairs manage to rear three broods successfully.

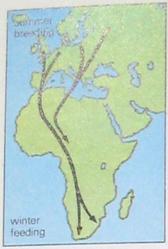
The birds you see gathering in flocks on the telphone wires for the autumn migration are generally young individuals. These birds do not have the pressing family responsibilities of the adults and spend their time generally making themselves familiar with the area to which, if they survive, they will return the following year to breed. Young birds are also the main occupants of the massive autumn roosts that form in reed beds throughout the country.

Migrating millions For centuries it was believed that swallows hid themselves in mud at the bottom of ponds throughout winter. People found it difficult to account for the sudden disappearance of the species every year in any other way. Even Gilbert White, the 18th century Hampshire naturalist famous for the accuracy of his observations, did not dismiss this idea completely. By the end of the 19th century, however, the migration of birds was established as fact, proved conclusively by the tracing of ringed birds. The 10,000 miles that swallows fly on migration to South Africa and back each year is a fact every bit as astonishing and marvellous as the supposed six month hibernation period under

Migration starts as early as the end of July in some years, and is in full swing from mid-August to the end of September. An early cold snap in October may catch lingering



At first glance, male and female swallows look very similar. But the male has much longer, thinnertipped outer tail feathers than the female; also the male's chestnut or rustred forehead and chin is often richer and darker than the female's. Both sexes share the glossy, deep blue upper parts, pinky-brown underside and white spots on the inner tail feathers. You can distinguish the juvenile in autumn by the short, blunt outer tail feathers and very pale forehead and chin.



Above: The route taken by swallows on migration to South Africa is a direct one, passing over western France, the east coast of Spain and Gibraltar. British swallows are joined en route by birds from Russia.

Below: Swallow drinking on the wing. The low, skimming flight over land or water is characteristic of this bird, which flies nearer the ground than any other in its search for insects. swallows unawares and inflict heavy casualties. In such circumstances thousands of weak and torpid birds have sometimes been gathered up from north of the Alps and flown in a plane further south where they have revived in the warmer conditions and continued their journey. This is a worthwhile gesture, but not one on which the European population of swallows relies for its continued existence—there are probably as many as ten million individuals migrating south each autumn from Britain alone.

The swallows' passage south is generally fairly leisurely-taking up to two months; the northward spring trip is much faster, often being accomplished in just one month. The birds travel by day in large flocks, feeding as they go so they do not have to put on a great deal of fat before the journey to use as fuel. At sunset the flocks settle for the night in roosts-usually in marshy reed beds where there is adequate shelter. Young birds find their way south by instinct; they do not have to be taught which route to follow by their parents.

Hazards en route The greatest barrier the swallows face on their journey is the Sahara desert. They can rely on favourable winds to assist them on the autumn crossing but they must nevertheless be in good condition, and with reserves of fat, before they can set out across the Sahara with any hope of survival. On the return trip in spring the winds are not

always favourable, and the area to the north may itself not be very hospitable. This part of the northward journey is therefore particularly risky and in some years there are mass fatalities in the desert and on its northern edge. Totally exhausted—and doomed—birds have been found still alive but weighing as little as 10g (\frac{1}{3}\text{oz}); their normal weight is about 20-22g (\frac{3}{4}\text{oz}).

Winter in the sun Swallows find an abundance of food and warmth in South Africa to keep them in good condition throughout the winter. The British population has shifted its wintering area at least once in the last 20 years. Up to 1961, only one British ringed swallow had been found in the south-western area of South Africa, but since then about a third of all records have come from there. Different populations of European and Eurasian swallows wintering in South Africa are quite well segregated. For example, German birds are generally found over 1000 miles north of the British birds, spending their winters in the Congo basin.

A few of our swallows are tempted to stay in South Africa all year round to nest and breed; but since there are 15 other native species to compete with for food, the majority undertake the incredible journey northwards each year to rear their chicks on the summer bounty of British insects.

More on migration in a later issue.



THE TREE TRUNK PLAYS HOST

The trunks and branches of ancient trees in damp areas of the British Isles are often festooned with flowerless plants of intricate shapes and subtle colours.

Look at the trunks and branches of different trees in a forest or a dense wood, and you will notice that the bark surface is often covered with mosses or lichens. Look closer, and you will see that these growths are very small and beautifully coloured flowerless or 'lower' plants.

Their existence, when you think about it, is quite remarkable for tree trunks are continually shedding both their outer bark and the plants that live on it. Tree trunks are also dry places, so you might imagine that few plants could live on them. Nevertheless, many plants have evolved to cope with tree trunk living, probably to escape competition from the undergrowth on the forest floor.

These plants are collectively known as 'epiphytes'. Most plants draw up food and water from the soil, but epiphytes absorb their nutrients from the air around them; the lushest growths of epiphytes are therefore found on trees in the humid western parts of the British Isles where the air is often saturated with water vapour from fog or rain.

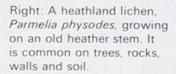
Delicate mosses and leafy liverworts form green mats on the relatively moist bark near the tree base; their minute leaves are often pleated or rolled to trap water. In the drier air higher up the trunk and on the branches, compact cushion-forming mosses—with upright stems (like a thick pile carpet) which trap water between them—are more common.

Lichens are either crustose and pressed to the bark or foliose—forming strange branching outgrowths. They festoon branches in woods of the West Country in particular, but most of them are too sensitive to pollution and aridity to thrive in many areas of the British Isles. Like mosses, they too absorb water over their whole surface, and anything dissolved in the water is absorbed with it, including pollutants such as sulphur dioxide and carbon monoxide produced by burning fuel or traffic fumes. In heavily polluted areas *Pleurococcus*, a tough microscopic alga which tinges tree trunks a dirty green colour, is the only epiphyte to be found.

Where epiphytes are abundant it is interesting to note how different species grow on different bark types. The trunks of old trees



Above: Tree lungwort (Lobaria pulmonaria)—one of the largest of the lichens—growing on a damp ash tree. Its presence often indicates ancient woodland.







grow relatively slowly, giving epiphytes an opportunity to gain a strong foothold. You see many in the deep fissures of oak and poplar in particular, but only rarely in the rapidly flaking bark of sycamores.

On areas of damaged bark there is often a distinctive epiphyte flora because the tree is exuding nitrogen-rich substances. In the rain tracks running down the barks of beech and elm trees, epiphytes that can withstand the forceful water flow benefit from the extra nourishment such as bird droppings dissolved in water. Some rare mosses grow in the axils of large branches. If dust and humus collect there, then even non-epiphytic plants like ferns may grow.

A rich and prospering collection of lichens used to be a much more common sight when the British Isles were relatively pollution-free. This group is growing on a sessile oak tree at Dizzard Point in Cornwall.

ON THE WATER

The thin film on the surface of water is a kind of mini habitat, supporting lightweight creatures that scoot about on top and feed on insects which fall on the water.

In spring the first aquatic insects to appear are pond skaters, bugs which belong to the Gerridae family. These seem to turn up suddenly on the surface of still waters everywhere; there are ten British species and you'll find one or another of them in most parts of the country. Strangely enough, the first thing you might notice are the shadows of the insects reflected on the bottom of the shallower parts of the water; these look like clusters of dark spots with light edges and show the ends of the legs resting in shallow depressions on the surface of the water.

Pond skaters, and some other insects, have successfully exploited a most unusual habitat which is intermediate between land and water -the surface film. This layer, although not chemically different from the rest of the water, is in a peculiar physical state of tension and acts rather like an elastic skin which can support small objects both above and below it. The pond skater is a small insect, up to 15mm (sin) long, but its extraordinarily long legs make it seem larger and spread the slight weight of the insect over a wide area. At the end of each leg there is a pad of bristles which depresses the surface film into dimples and prevents the legs from breaking through the water. Using a kind of rowing motion of their long middle legs, the insects can glide over the water as confidently as an experienced ice skater.

The surface film has two great advantages as a habitat for pond skaters: relative freedom from predators and a superabundance of food in the form of innumerable small aerial insects that fall on to the water and cannot get off again. The struggles of potential prey alert the pond skater which glides rapidly towards its victim and seizes it with the short front pair of legs. Using its sharp rostrum or beak, the pond skater then sucks out the body fluids of its victim. There are both winged and wingless pond skaters.

Pond skaters lay eggs in about March or April and attach them in small groups to submerged or surface plants depending on the species. The emerging young, as in all bugs, resemble their parents in everything but size and develop through several moults.



Other surface skaters Water crickets (family Veliidae) and water measures (Hydrometridae) are relatives of the pond skater and are equally well adapted to life on the surface of the water.

The two species of water crickets, both of them rather smaller than pond skaters and with shorter legs, often inhabit slow rivers as well as still waters, even in winter. In fact, they are not crickets at all and don't make the cricket's characteristic chirping sound. They are only about 7mm (\frac{1}{4}in) long when adult and you need a lens to see their handsome orange-red back markings and orange undersides. Water crickets support their weight mainly on their front and hind legs and

Above: The long legs of the adult pond skater enable it to glide at speed across the surface of the water. A small pad of bristles at the tip of each leg dimples the surface and stops the leg breaking through.



Left: The pond skater relies for its food on the numerous small creatures which fall on to the water and cannot get off. This species, *Gerris gibbifer*, one of ten British pond skaters, is feeding on a fly trapped on the surface layer.

move their middle pair of legs alternately, not simultaneously as pond skaters do.

The commoner of our two species of water measurer. Hydrometra stagnorum, is about 12mm (1m) long and is found in most parts of Britain. Hydrometra gracilenta, slightly smaller, is restricted to a few localities in the Norfolk Broads and the New Forest. Water measurers are extremely hard to see, partly because they have such remarkably slender bodies and partly because they tend to stay among vegetation at the edge of still and flowing water. Whereas water crickets are quick in their movements, water measurers move very slowly and the apparent pacing out of distances accounts for their common name of measurer. Both groups of insects feed on small creatures trapped on the surface film, but the water measurer can also catch small animals such as water fleas and mosquito larvae just below the surface. Both crickets and measurers attach their eggs, laid in May and June, to waterside plants.

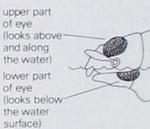
Whirligig beetles Twelve species of whirligig beetle, of the family Gyrinidae, live on the surface film of the water. Gyrinus natator is one of the commonest species and is found throughout Britain. This tiny black beetle, only 5-6mm ($\frac{1}{4}$ in) long, lives in schools on open still or slow-running water, performing endless gyrations at great speed as it searches for prey floating on the surface. It is beautifully adapted for this mode of life, with a smooth, shiny, streamlined body and curiously modified middle and hind pairs of legs, each segment of which is flattened and fringed with hairs to increase the surface area. On the backward swimming stroke the plate-like sections of the legs present their broad surface to the water, but on the return stroke they fold up and offer little resistance. When alarmed, the beetle dives rapidly down into the water. The front pair of legs is used for grasping prey. The beetle has curious eyes, specially adapted for its way of life; they are divided into two parts, the upper able to see above and along the surface of the water, the lower part positioned to look below the surface.

Whirligig beetles lay their eggs from March to May on submerged vegetation. The larvae, which take about a year to develop, are long and narrow and have long tracheal gills on each segment of the abdomen which enable them to absorb dissolved oxygen from the water for respiration. They creep out of the water at the beginning of August and make a greyish pupal cocoon some distance up a plant stem. Although there must be great numbers of these cocoons about, they are so well hidden as to be very rarely seen. The adult beetle emerges from the pupa towards the end of August. During severe spells of winter weather, the beetles may bury themselves in the mud at the bottom of the water, but in mild spells they come up to hunt for food.



Spider predator In certain areas in most parts of the country you may find a large, strikingly marked spider sitting at the water's edge with its front legs resting on the water surface. This unmistakable spider, known as the swamp spider, with brown body and white stripes is our largest species; females can be up to 20mm (3in) long and males about $12\text{mm}\left(\frac{1}{2}\text{in}\right)$. It too walks on the water surface. Ripples caused by any disturbance on the water, such as the movements of the surfacedwelling insects or the struggles of other creatures which have fallen on the water, are detected by the spider's front legs. As soon as a likely victim is located, it darts across the surface of the water to catch it.

Above: The middle and back legs of this whirligig beetle are flattened and fringed with hair for swimming. Below: Enlarged head of a whirligig beetle, showing the positions of the two parts of the eye.



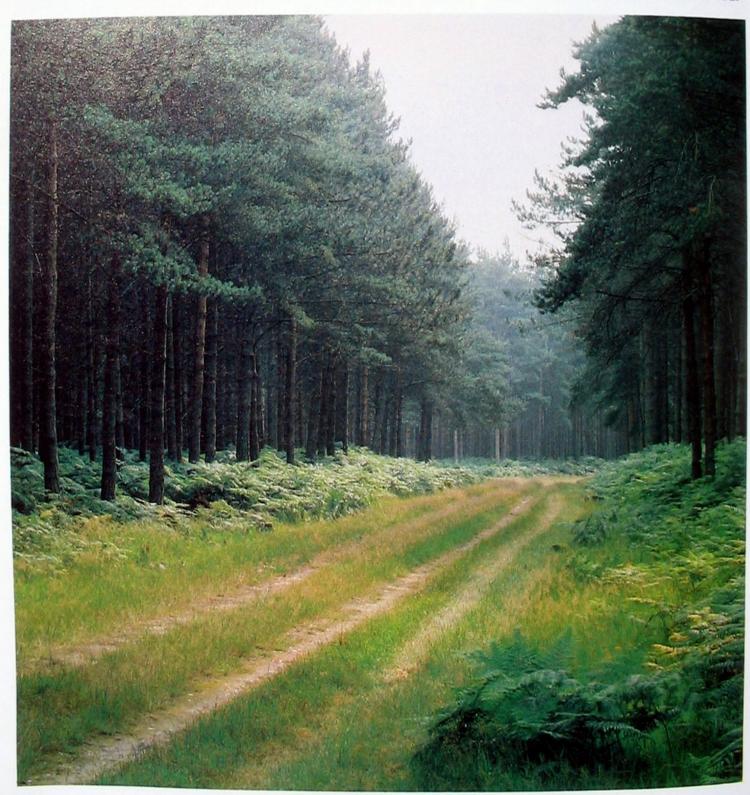


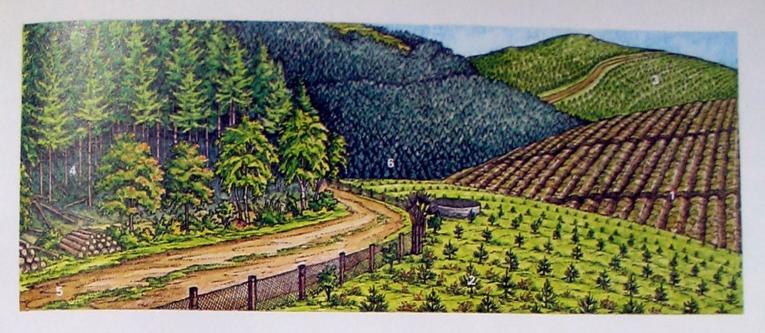
LIFE IN CONIFER PLANTATIONS

Conifer plantations are not all dark, lifeless rows of silent trees. In well-managed forests, blocks of trees-from the newly planted to the mature-create a patchwork of mini habitats in which a variety of wildlife finds refuge.

Devoted naturalists tend to decry the role of conifer woods, regarding them as little more than uniform carpets of alien species planted without any consideration for landscape and so dense that they blot out sound and light. To put conifers in context, it is probably more realistic to compare them to modern agriculture than to deciduous woodland. They will never be as rich as the more natural deciduous woods, but they are an intensive, economic way of using land. The plantations are monocultures like the farmer's wheat and silage crops; the rides and fire-breaks function like hedgerows and lanes.

When compared to agricultural land conifer plantations often appear in a more favour-





Stages in a plantation A forester's plantation often contains blocks of trees at

different stages of growth. The illustration shows six main stages.

WEY

KEY

1 A piece of newly-dug land, with narrow trenches down the hill and drainage channels across, ready to be planted.

2 Five-year-old pines planted three years ago.

- 3 A fire-break through a block of ten-year-old spruces.
- 4 After about 20 years some trees are felled to allow others to grow bigger. The felled wood is stacked at the roadside.
- 5 Small plants can establish themselves at the edges of rides. Fire beaters and a water tank are nearby in case of fire, and a rabbit fence protects the young
- 6 A 70-year-old plantation ready to be felled. This is done in large sections over about ten years.

Left: Conifers cover 7% of the land in Britain, and almost 5% in Ireland, Most pine plantations are managed on a 60-80 year cycle. Even when the canopy is at its most denseafter 10-12 years - birds can nest in the thick branches. Thereafter the trees are felled at intervals of about five years and the felled areas are quickly colonised by the grasses, bracken and flowers that grow at the edges of the more permanent rides.

able light. But to say this is not to advocate the planting up of good quality agricultural land, much less downland, species-rich meadow, remnants of lowland heath or deciduous woodland. Such a policy could only be to the detriment of wildlife. However on poor, often upland soils, where the land only supports scrub, the planting of conifers provides a welcome habitat for a number of plants and animals.

Initial disadvantages Why can a coniferous plantation never be as rich as a good native broadleaved wood? To start with, the trees in each conifer block are uniform in age and evergreen, unless larch is the main species. In addition to consisting mainly of alien species, they are planted at regular intervals, and so are of the same height and provide the same density of cover. This planting policy is designed for ease of felling and thinning. There are no old trees to provide nesting holes for birds and roosts for bats and no broadleaved species to provide the quantity and variety of invertebrate life on which predators can feed.

Once the canopy layer is established (after 10-15 years in a pine wood) there are no undershrubs, very little cover for nesting at ground level, few flowers for insect pollinators, or fruit for voles, mice and birds. The lack of light when the conifers are at their most dense ensures that apart from fungi there is little ground flora. Without the ground flora and its seeds, herbivorous small mammals and invertebrates are reduced in number. This in turn restricts predators, such as ground beetles, shrews, weasels and birds like the robin and great tit. The accumulation and slow decay of pine and larch needles can make the soil acidic. Acid soil is inhospitable to various soil organisms such as worms and bacteria and to many flowering plants. Finally, most plantations contain little or no dead wood, a habitat which in deciduous woodland can contain up to a third of the species present, including beetles,

ants, bees, wasps and woodlice.

Diversity of habitats With what appears to be so many negative aspects, it is hardly surprising that some people object to coniferous plantations. But in large plantations divided into many compartments or blocks the habitat diversity is often considerable. The felled areas allow opportunists like the foxglove, and on sandy soils possibly heather and bell heather, to move in. As the new trees grow up these plants will disappear to be replaced by wavy-hair grass or perhaps broad buckler fern after the trees are thinned.

The power line tracts, fire-breaks and rides allow light to penetrate at the margins and here a variety of plants is often found together with butterflies, hoverflies and bees. On sandy soils, such as in parts of Sherwood Forest in Nottinghamshire, sand spurrey, pill sedge and various grasses are to be found. Where limestone chippings have been used for forest roads or when the plantation is on chalk or limestone, then many species associated with limestone grassland persist at the edges of the dark wall of conifers.

Apart from these opportunist species, if the planting policy provides stable areas which are not disturbed, for instance rides, heathland plants can flourish. The clubmosses might find room among grassy or rocky edges. Indeed, in lowland areas, the forests are becoming increasingly important for this group of plants as their natural heath and moorland habitats are in decline.

Temporary visitors Animal life in the plantations can be more varied than the plant life. As the forest matures, the animal population changes. At first the exclusion of grazing animals, which would otherwise eat the young trees, allows the growth of a thick wall of grasses to develop. This attracts short-tailed field voles, whose runs and holes soon riddle the grassy tussocks. In turn the voles provide food for the magnificent short-eared owl. Spiders, beetles and other invertebrates prefer the damp, dark conditions at the base of the



Above: Rosebay willowherb grows in profusion between Scots pine and birch trees in this 9-year-old plantation on Arnfield Moor in the Peak District. As the trees grow taller they will gradually shade out the willowherb until only a few hardy grasses remain.

Right: Pine martens have benefitted from the spread of coniferous plantations, particularly in Scotland. They are extremely agile tree climbers and feed mainly on rodents and small birds.





Left: You have to look hard at the canopy of conifer trees to spot the goldcrest's nest, usually suspended from a branch. Goldcrests, like pine martens, have increased in number with recent afforestation.

grass tussocks under the litter and so predatory shrews and foxes as well as insectivorous birds, such as tree pipits, grasshopper warblers and linnets, are often seen in the plantation.

As the trees grow into a dense thicket, these birds decrease and their place is taken by wrens, willow warblers and hedge sparrows which choose the thickets for nesting. Once the trees reach 3-4m (10-13ft), thrushes, blackbirds and chaffinches begin to nest. At this stage the lower branches of the trees are removed—a process called brashing—to prevent knots forming in the wood and reduce the risk of fire. Animals needing a dense undergrowth such as voles are forced out.



Above: This fungus, *Boletus* variegatus, (not edible) is one of many that can grow in the shade of dense conifers.

The taller trees, however, provide nesting sites for jays, crows and magpies. It is at this stage that the canopies of mature trees can become an important breeding site for gold-crests. Coal-tits, which do not compete very successfully with other tits in deciduous woods, find refuge in these older plantations. Squirrels are able to find suitable branches to build their dreys, and it is the red squirrel in particular which is associated with pine plantations.

Changes in bird population Once the trees are thinned, after about 20 years, many of the song birds seem to leave. The trees are usually thinned every five years and so the canopy is less dense from this stage onwards. The tall trees are still used as roosts by owls and you can often find their pellets scattered around on the ground beneath. Both the long-eared owl, a bird of northern Britain, and the sparrowhawk, whose numbers are now increasing, prefer to nest in the old pines that survive in woods which are not commercially managed. The increase in pine woods has played an important part in the recovery of populations of what were once quite common species. These include birds such as the siskin and crossbill (which feed on the pine seeds) as well as mammals like the pine marten.

The Forestry Commission has made particular efforts to protect and manage the herds of deer in the new forests. In Scotland these are mostly red deer but in England there are fallow, roe and more locally muntjac deer as well. Culling of the herds is necessary to keep them to a manageable size and so prevent too much damage to trees. Such management also includes mowing the rides and retaining open glades within the planted areas to provide the deer with grass.

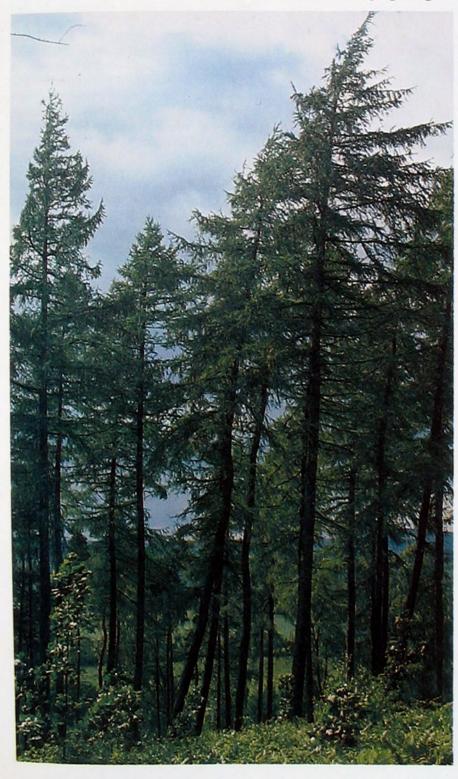
Planning ahead Coniferous plantations are a monoculture and, like all monocultures, they are susceptible to devastation by pests particularly large numbers of a single species; moth larvae are often the worst offenders in coniferous plantations. It has been suggested that by providing a more varied habitat, the forest managers could use wildlife to reduce the possibility of such outbreaks. In Germany wood ants have been introduced into plantations to control caterpillars and leaf-eating bugs. Studies at Thetford Chase indicate that visiting flocks of tits may take as much as 20% of certain moth pupae and larvae in winter from the coniferous trees, but they need to be supported by the provision of more deciduous trees to help them feed broods in summer.

Although coniferous plantations can never be as rich as the more natural broadleaved woods, nonetheless they do provide what are, occasionally, important reservoirs of wildlife. And, if managed thoughtfully, the forests could not only help to maintain the diversity of species in Britain but even enable the wildlife they do support to contribute to the success of this particular form of economical land use.

GRACEFULLARCHES

The European larch is oblivious to cold winters but needs plenty of rainfall during the growing season. It is small wonder then that it manages so well in the British Isles.

Beautifully delicate, yet amazingly resilient to bitter winters on the mountainsides, larches are our only conifers to shed needles in autumn and grow brilliant green new foliage the following spring.



The larch is a lofty tree with a tall straight trunk that tapers to a sharp point, from which graceful drooping side branches radiate in all directions. Among Europe's conifers, it is unique for its habit of losing its leaves in autumn, standing bare and gaunt throughout winter.

The European larch was introduced into this country early in the 17th century. For about 150 years after its arrival it was planted just as an ornamental tree until its value as timber was realised. In the wild the larch is a mountain tree and in regions of central Europe larch forests grow as high up as 2000m (6500ft).

The larch's great advantage as commercial timber is that it is ready to be cut after only 40 years-half the time taken by our native broadleaved trees to reach maturity. Growth is amazingly rapid: starting in May, slowly at first-2cm (\frac{3}{4}in) a week-but gathering apace to 10cm (4in) a week in mid-summer.

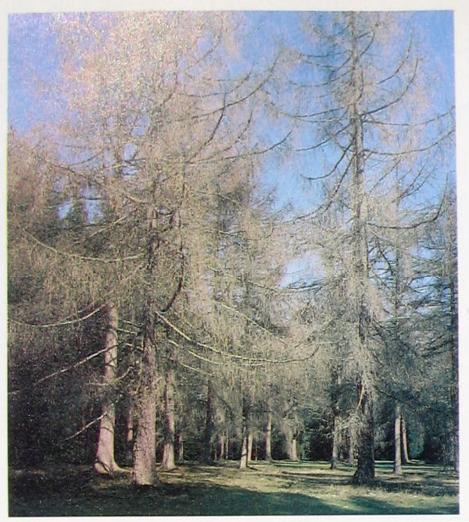
Foliage The light green foliage emerges in April, darkens during summer and then fades to golden-brown in October before falling. The leaves, or needles, sprout in bunches of 30-40 from little knobbly outgrowths on the twigs.

Flowers Separate male and female flowers appear on the twigs when the tufts of young needles begin to show themselves. The rather inconspicuous male flowers at the tips of the twigs develop into compact clusters of yellow anthers that mass-produce pollen; this is then wafted away by the wind. Just a fraction reaches and fertilises the female flowers, which are made up of a rosette of overlapping reddish-purple scales, aptly named 'larch roses'.

Cones After fertilisation the scales that were soft in flower harden to form egg-shaped cones, green at first but turning brown in autumn. As the cones ripen and dry, the woody scales slowly open to allow the seeds to slip out, though it may be several years before all the seeds inside a cone are released. Each seed is equipped with a triangular wing which acts like a sail so it may be blown some distance.

Animals are also often responsible for speeding up the process of dispersal. Squirrels spill hundreds of seeds as they gnaw the cones; and birds, such as crossbills, have beaks well-adapted for prising open all kinds of pine cones to get at the seeds inside.

Hardy tree The larch shows a number of adaptations to the harsh winters of its natural mountain habitat. Firstly, it is deciduous. If it kept its delicate foliage in winter, it would lose more water by evaporation through the leaves than its roots could possibly extract from the freezing soil. It therefore sheds them to avoid drying out and dying of thirst. (Other conifers survive because their needles are harder and tougher and covered in a thick waxy cuticle, so the rate of water loss is reduced.)



Above: Larch in winter, showing the gracefully shaped branches. Like most conifers, the side branches are thin and flexible; they can bend without snapping under the weight of snow and spring back up again when the snow slips off.

Secondly, the twigs droop downwards from the side branches. This arrangement gives the leaves plenty of exposure to light in summer, but also means that the branches do not catch snow in winter. Also the cells of the wood are structurally very strong and can survive losing large amounts of water. When this happens the sugary sap freezes at a lower temperature than water.

Plantations Larches are often planted with native hardwoods to encourage the hardwoods' growth. The broadleaved saplings have to grow faster to keep up with their larch neighbours or else they would simply be shaded out of the race to the light. In this capacity larches are known as 'nurse' trees.

Foresters rarely allow plantation larches to live out their natural lifespan; but ornamental trees can reach quite an old age. There are some fine specimens growing at Dunkeld in Perthshire which are over 250 years old. In fact larches do not grow old elegantly and tend to become rather untidy trees. They lose the compact symmetry of their youth because branches are blown down in gales, leaving gaps in the conical crown, and the straggling side branches vary a lot in curvature and length. And as the trees age, the bark becomes thick and deeply furrowed.

Larch timber is tough and extremely resilient out of doors. So it is valuable for allweather purposes because it can endure constant changes from wet to dry without



Right: A fine view showing larch growing near Ulpha in the Lake District. Larch plantations are particularly attractive to wildlife as they allow in more light than other confers.

Japanese larch (Larix kaempferi), introduced, deciduous, grows to 35m (115ft). A particularly hardy pioneer tree.

European larch (Larix decidua), introduced, deciduous, grows to 50m (165ft). May live over 100 years; commonly felled at 40 years. Both larches grow on well-drained soils. Flowers March-April, cones ripen Oct.

warping, cracking, shrinking or distorting.

Japanese larch Introduced in 1861, this larch is distinguished by its darker blue-green needles and bright orange winter twigs. It appears even better suited to our climate and grows faster than its European cousin. It is also much more resistant to larch canker—a devastating fungal disease. What has interested foresters recently, however, is the natural marriage of the two species that resulted in the Dunkeld larch, named after the place where the cross was first noticed. Like many hybrids, it probably has a bright future because it is even hardier, grows faster and is more resistant to disease than either of its parents.



Left: This beautiful larch rose has just been dusted with golden pollen grains. It will develop into a cone about 4cm (1½in) long by autumn, but will probably not release its seeds until the following year.

Window on the past

A peculiarity of conifers is that if their trunks or limbs are injured they bleed resin from the wound. Resin is a transparent sticky liquid comprising a wax or rosin dissolved in turpentine, which seeps over the damaged tissues. The turpentine evaporates, leaving a coating of rosin sealing the wound. This acts like a greaseband, gumming up potential insect pests and also shielding the tree from fungus spores. (Turpentine itself is a useful byproduct from conifers such as pine and larch, and rosin is used by musicians for waxing the bows of stringed instruments.) We know that this defence strategy has been in operation for at least 70 million years, for the resin eventually becomes buried and fossilised into lumps of amber. Amber provides us with a fascinating glimpse into the past because it frequently includes perfectly preserved insects and plant remains. Much of what we know about the wildlife of primitive forests has been gleaned from the study of amber. Insects crawling over or landing on conifers run the same risk today as they did all those years ago. Should they be in the path of or touch down on the sticky drops, they soon become hopelessly stuck and eventually engulfed by the flow of

Amber, highly prized for its warm shades of yellow, orange and brown, was one of the



first substances used to make jewellery. Worked amber ornaments unearthed at Stonehenge and elsewhere date back to 9000BC. The best quality amber now comes from the Baltic coastline of Russia and Poland, where it is mined and exported. But it is also dispersed by the sea, whose pounding waves and currents carry it considerable distances. Beachcombing on Britain's North Sea coast, especially around Norfolk and Suffolk, you may well find a lump of amber that has floated over 600 miles.

Ants and flies are two insects found entombed in amber. Often frozen in a macabre death pose with wings askew and legs twisted and splayed, they show all the signs of a frantic struggle to break free. If amber blocks are thinly sliced, microscopic analysis of the sections can unravel the secrets of the internal structure of ancient invertebrates as precisely as if they had just been caught.



It is hardly surprising that the grey squirrel makes its home in wooded areas since its main source of food especially in autumn is the nuts, foliage and fruits that trees produce. Unfortunately the damage the squirrel can do to the bark of trees, which it gnaws for the sweet sappy tissue underneath, has led to its persecution by man. When driven from the woods, the grey squirrel will adapt to open country, as long as sufficient shelter is provided by hedges, bushes and individual trees.

Since its numerous introductions between 1877 and 1929 into the British Isles from North America, the grey squirrel has colonized most areas. However, in parts of north Norfolk, the Lake District, Northumberland and north Durham the red squirrel is the

dominant species.

Versatile dweller Outside its natural woodland habitat, the grey squirrel has been known to cross water, marshland and bogseven to swim rivers. It has adapted well to different environments including urban areas. You will often find it in town parks and gardens, in fact wherever there are hedges, bushes or trees in which it can make a home.

The squirrel has become so familiar with these populated surroundings that it sometimes appears almost tame, and takes food from the hand if approached carefully. People living in towns are also well aware of the raids made on bird tables. In an effort to prevent this, some people hang nets of nuts from plastic clothes lines. This does not however deter the squirrel, which finds its way along the slippery line and, turning upside down like a blue tit, hangs by its hind feet to get at the nuts.

Squirrel signs Even if you know where to look for grey squirrels, you may not always see them immediately since they have a marvellous ability to camouflage themselves. An obvious place to look for them is up in the tree-tops where they build their nest (drey). Even if the squirrels are too quick to catch sight of, you may see their tracks between the base of trees. About 3cm (14/4in) wide, these tracks show the four distinct claws of the forefeet and five of the hind feet; usually they are widely spaced with no signs of tail-dragging.

Another sign to look for is the stripped bark on the trunk of hardwood trees. You may also find split shells or husks of nuts and fruit, cut tree shoots and buds, strips of bud scales or toothmarks on fungi. And listen for the characteristic scolding cry of 'chuk-chukchuk', which you may hear before you see the

squirrel.

Coat colouring The grey squirrel's summer coat is short, sleek and brownish-grey on the top of the body with a chestnut streak along the flanks and feet and often on the outer edges of the limbs. The tail hairs are thin with an indistinct white fringe. The winter coat is thicker and silver-grey on the top of the body, with yellowish-brown fur on the head and

along the flanks; the legs and feet are grey, while the underneath of the body is white. The large, conspicuous bushy tail has dark grey fur with a white fringe. There is little difference in colouring between the males and females, but the young-before their first moult-usually have a greyer summer coat than the adults.

In certain areas you will notice some distinct variations in colouring. In southeast England you may even see white squirrels, particularly in Kent, Surrey and Sussex. These are albino greys and have reddish eyes—like all albinos. Some grey squirrels in this area have red-brown backs and can be confused with reds. In Bedfordshire, Cambridgeshire, Hertfordshire and Buckinghamshire you can find black (or melanic) squirrels. These are the descendants of about a dozen black squirrels introduced into the Woburn Estate in Bedfordshire shortly after the arrival of the first greys.

Incessant nibbler The grey squirrel gnaws at almost anything that grows on trees, including the tree itself—or more precisely the sappy tissue found under tree bark, especially of beech. It will occasionally take birds' eggs and even young birds and insects. In other habitats it will also eat farm crops such as swedes, wheat, barley and oat shoots, and the grain from these cereals at the 'milk' stage, as well as when ripe. Fruits, such as apples, pears, plums, cherries and strawberries, also supplement its diet. It will eat soil, too, for its mineral content and to provide roughage.

All rodents have teeth which grow continually and must be worn down before they become dangerous and possibly pierce the palate. With the squirrel these are the incisors, which are trimmed by continual gnawing on nuts and seeds. The squirrel takes its normal water requirement from food and from the dew. In hot weather, however, it may even drink from lakes, ponds or puddles.

Eating habits The squirrel gnaws its food on the spot or carries it to a safe eating place—either somewhere high in the trees or on a fence post or tree stump, where it can keep an eye on its surroundings. The squirrel's eyes are large and set in the side of the head to give wide-angle vision. It also has an acute sense of smell, but its hearing is unexceptional.

The squirrel nibbles hazelnuts at one end until it can insert its lower incisors and split the shell; other nuts and mast with softer shells present no problem. It will also gnaw off pine cone scales and eat the seeds.

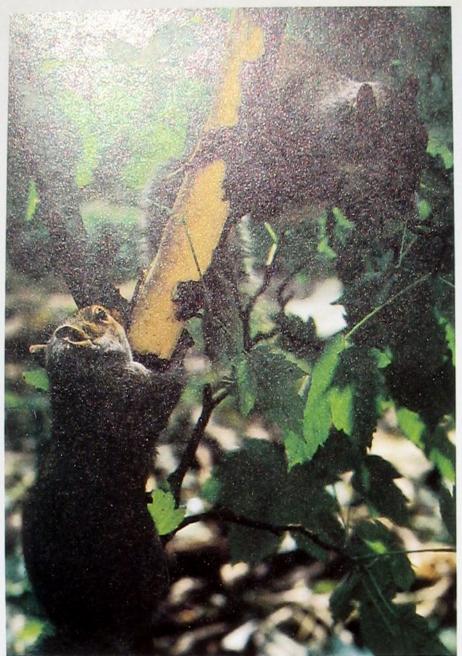
April to July is the favourite season for bark-stripping. If the squirrel gnaws completely around the trunk, the tree will probably die, making squirrels very unpopular with foresters.

In the late summer and autumn the grey squirrel methodically sets about establishing caches to store its winter food. It will later remember the rough location of the cache and then smell out the exact position. Sometimes





Above: The squirrel's forefeet are ideally suited for clutching food while the animal nibbles away, as shown by the grey squirrel gnawing at a hazelnut (far left). The longer hind feet help it to balance and get a firm grip on the branch.



Above: Stripped bark is one tell-tale sign that the grey squirrel is about—and this habit has made the animal a pest in the eyes of farmers and foresters. These two are making a meal out of a sycamore tree.

Right: Storing nuts in the ground is a vital business if the grey squirrel is to survive the cold winter months. Normally it will smell out its cache when the food is needed, although nuts left undiscovered may later sprout.

it forgets where the food is hidden and here you will often see stored nuts sprouting.

Agile traveller The squirrel is extraordinarily graceful and agile and can run up and down tree trunks, no matter how smooth the bark, with the greatest of ease. It will balance on the flimsiest twig and leap from branch to branch and tree to tree with complete confidence using its tail as a rudder.

On the ground the squirrel progresses in a series of short leaps or runs on an erratic course with its tail held out straight behind. It can reach speeds of up to 20 miles per hour. It pauses frequently to reconnoitre and sniffs the air, sitting upright on its hind feet with its tail flat along the ground and its ears erect. Surprisingly, the squirrel is an adept swimmer; it keeps its head and tail above the water, with the tail held up in its characteristic curve like a bushy sail.

Cycle of activity The squirrel is active during the day, beginning before sunrise and ending well before sunset. It does not like extremes of temperature and in such cases will retreat to the cover of its drey. It cannot, however, spend more than two or three days without food and often comes out of the drey to forage even in adverse weather.

Until recently it was mistakenly thought both grey and red squirrels hibernated during the winter or slept for long periods. Although you are unlikely to see squirrels in cold weather, they are about since their presence is given away, for example, by tracks in the snow.

Apart from games played by the young and the play which forms part of the courtship ritual, male squirrels spend a great deal of time in high-spirited chases through the tree tops, tail-biting and screaming. Whether this is play or aggression is not known. Apart from the 'chuk-chuk' call, listen also for a barking note, variations of purring





Tree-top families

Once she is pregnant, the female squirrel drives out the male and prepares the drey for her young by giving it a soft lining of grass, dry leaves, moss and any other available soft materials.

In the drey the female produces her young twice a year, six weeks after mating; this means litters appear in earlyto-mid spring and mid-to-late summer. The young-usually three per litter-are born naked, blind and deaf; each weighs about 15g (3oz). They rely entirely on their mother's milk for seven weeks. After that the mother introduces them to solid food, but continues to suckle them for another three weeks or so. By this stage the young start to learn the tightrope tricks that mean survival in the tree-tops, while also foraging and feeding themselves.



noises and a vibrating sound (like the song of a grasshopper) made by males chasing

Courtship The grey squirrel has two mating seasons, the first occurring in May and the second in December. Courtship rituals involve display and chasing; a number of males sometimes pursue a female just before mating time, simultaneously engaging in running contests to see who gets the prize.

Preparing the drey The squirrel's nest (drey) is rounded (about the size of a football), close-knit and made of leaves, twigs, bark, grass and pliant stems of ivy. Found mostly in hardwoods, it is often built away from the main trunk of the tree. Each drey is isolated and from a distance is easily mistaken for a crow's nest, although the latter is an untidier

After mating the female becomes the dominant of the sexes, driving out the male from the nest tree and constructing the drey in which she will give birth. As an alternative she may enlarge a previous one, or sometimes make her den in the hole of a tree trunk, possibly taking over a woodpecker's old nest.

The female squirrel is a model mother and weans her blind and furless infants with great care, licking and cleaning each one individually. By the time the young squirrels are ten

weeks old they are scrabbling about outside the drey and within another three weeks they are out on their own. They either wander away or are turned out by the mother, who must soon prepare for her next litter. Young female squirrels are capable of breeding six or seven months after birth and usually do so by the time they are a year old.

Resisting attack The grey squirrel avoids most of its predators by living in trees, but it is still vulnerable to owls, hawks, wild and domestic cats, dogs and occasionally stoats. Birds and squirrels co-exist quite happily for the most part, although occasionally birds will mob a squirrel.

The greatest enemy is undoubtedly man. Squirrels cause extensive damage to valuable hardwoods and, since the 1920s, strenuous efforts have been made to curb the population. Dreys have been destroyed and squirrels shot, trapped, poisoned and set upon by dogs. In 1937 the Government prohibited the importation and release or the keeping of grey squirrels in captivity-except under licence. All these measures were to no avail and the problem has yet to be solved.

Later articles deal with the red squirrel, and why it has been unsuccessful in competing for habitats against the grey squirrel.



GREY SQUIRREL (Sciurus carolinensis)

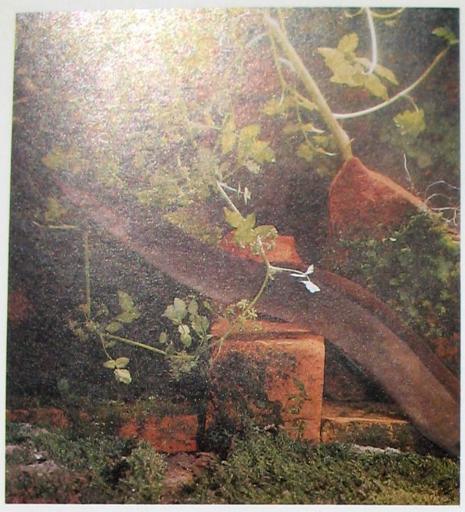
Size of adult 25-30cm (10-12in) over head and body: 20-22cm (8-9in) along tail. Weighs about 500g (17oz), females slightly less

Breeding season Jan-July Gestation period 42-45 days

No of young average 3,

range 1-7 Lifespan known to live 8-9 years, but less than 1% reach more than 6 years Food bark of oak, beech; acorns, nuts, fungi Predators birds of prev: wild cat; casual huntersstoat, pine marten, fox; control by man; traffic Distribution Throughout England and Wales where there are trees; lowland Scotland and central

counties of Ireland.



MYSTERIOUS TRAVELS OF THE EEL

The remarkable story of the eel starts and finishes deep in the Atlantic Ocean, but how it navigates the thousands of miles to and from Europe remains a mystery.

In March and April, adult eels spawn in the deep water of the Atlantic Ocean including the Sargasso Sea north-east of the Caribbean, and then die. Meanwhile the tiny larvae that hatch from these eggs start their long journey of over 3000 miles across the Atlantic to Europe. Here the young eels move into rivers, streams and lakes to develop until, some years later, they are ready to leave their freshwater habitat and return to the sea to breed.

Atlantic crossing Young eel larvae, which are called leptocephali and look rather like transparent leaves, are about 5mm (4in) in length—quite unlike the long snake-like adults. Indeed, they were once thought to be a separate species of fish until, at the end of

Above: The common eel (Anguilla anguilla) undergoes many transformations in its life cycle. Here, in its yellow eel form, it develops tiny scales so deeply embedded in its skin that you cannot see them.

Below: This grid-iron eel trap has caught silver eels as they try to return to their breeding grounds to spawn. This 'run' of eels only happens on pitch black nights, often after a storm when the water is dirty.

the last century, scientists kept some leptocephali alive in a tank and discovered that they turned into young eels. It was not until the 1920s that the larvae's journey across the Atlantic was plotted in any detail. A Danish scientist charted their growth over the migration route and concluded that the Sargasso Sea, where the smallest specimens were found, must be the eels' spawning ground. However no one has yet proved this.

It is thought that eels lay their eggs in very deep water and in early summer the newly hatched larvae rise to the surface, where they feed on plankton. During their first year they grow rapidly as they are carried across the Atlantic by the Gulf Stream and other currents moving towards the European coast; this migration lasts about three years. Any larvae drifting too far north die.

Elvers in estuaries When the larvae reach coastal waters they stop feeding and change into elvers-miniature versions of adult eels, also commonly called glass eels because they are transparent. As they move through the brackish water of estuaries and into the fresh water of rivers and streams, they soon darken in colour. In the British Isles this movement, which occurs in almost every river, takes place in winter and early spring; a wellknown location is the river Severn. Some elvers stay behind in the muddy water of estuaries, feeding on shrimps, worms, crabs and small fish. (There is no truth in the theory that these are males and that only the females move upstream.) The journey up the estuaries is hazardous, with sea birds and fishermen taking their toll.

Travelling upriver Once in the rivers the elvers' progress upstream may be helped by man-made eel passes, which allow them to move over waterfalls, locks, dams and other obstacles in their path. The water flow is checked by a tube of wire netting filled with straw, heather or twigs, which the eels can use as a kind of ladder up and over the obstruction.

By the second winter in fresh water, eels have trebled in length, feeding on small snails and insect larvae. Eels are nocturnal animals, hunting for food at night and hiding



in mud, vegetation or under stones during the day. Those that live in the colder northern areas spend winter hidden in mud or under stones.

Yellow eels Eels continue to grow in the years they spend in their freshwater habitat. During this time they are called yellow eels, because they have a yellow belly; the back is brown. A yellow eel has a soft body, a broad snout and small eyes. These details are worth noting since the eel undergoes yet another change later in its life, and the difference in size and colour between the yellow eel and the final stage in its life cycle used to cause a lot of confusion. Many believed that the two forms were in fact different kinds of eel, until it was discovered they were merely two stages of growth.

Silver eels Exactly when yellow eels become silver eels, with a silvery belly, pointed snout and a hard body, varies enormously and occurs when the eels are anything from four to more than ten years old. The eyes grow bigger, but the reason for this change is not clear. Certainly it is not to assist hunting for food, since they stop feeding at this stage. Males develop into silver eels about two years before the females.

Long haul home Autumn is the time when silver eels begin the migration downstream on their way to the breeding grounds in the Sargasso Sea. Recent research indicates eels are not sexually mature until after they reach



Right: Elvers measure 6.5cm (2½in), shorter in fact than the fully grown larvae. Their journey up the estuaries is not easy. They escape the seaward drag of the tide by burrowing into the sand, but they are vulnerable when swimming, especially to the fisherman's eel net (above). The elvers are trapped as they move against the current and taken to eel ponds.

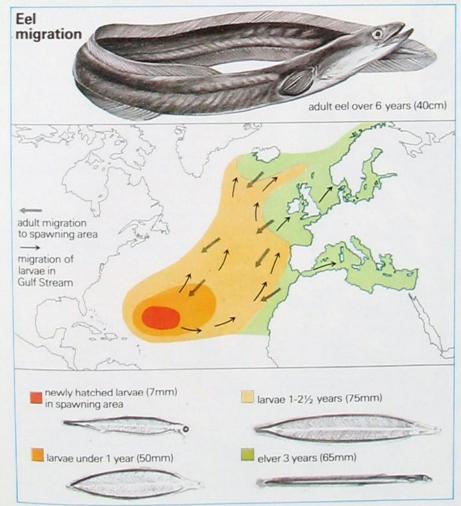


the open sea, although very few eels have been discovered at this stage. The fact that years ago eels' eggs or newly hatched fry were never found caused much speculation about their reproduction, including the belief that eels were sexless and had some mysterious method of breeding.

In research it has been shown that migrating eels cannot be deflected from their seaward route—and that captive eels become restless when river eels start their journey. On their way to the sea they travel along rivers, streams, ditches and other waterways—even overland on dark wet nights, when their thick skin and narrow gill slits prevent them drying out.

Although the migrating silver eels do not feed, they have plenty of stored fat—up to a quarter of their body weight—to sustain them on their journey; captive silver eels can live for several years without food. In the sea, the mature adults reach their destination in the spring, anytime from 6 to 18 months after leaving the fresh water.

Little is known about how the eels navigate across thousands of miles of ocean. Even today, few adult eels have been caught in the sea—and those only in coastal waters; but they may be guided by the increase in temperature and saltiness of the water as they head towards the Sargasso Sea. Once there, the eels lay their eggs, fertilise them and then die. No eel ever returns.







Left: Wood anemones among lesser celandines in mixed woodland in Hertfordshire. You can tell it is a sunny day as the flowers are wide open. On dull days they close and droop to protect the pollen.

Wild arum (Arum maculatum) flowers April-May, fruits July-Aug in woods and shady places. Ht 40cm (16in).

emerge early in the year and the flowers follow in April. By the end of the summer the flowers and leaves have died back completely and all that remains is the bulb.

Under dark hedgerows and beside streams you may see—or smell—the garlicky ramsons. Their delicate spiky white flowers are starlike with six-pointed petals and long stamens and the glossy leaves twist through 180 degrees, like those of lilies-of-the-valley. The leaves can be used to flavour stews and fish.

Oxlips, once widespread in old woods, are now confined to the boulder clay area where Essex, Cambridgeshire and Hertfordshire meet, and further south in a few woods on the Hertfordshire-Buckinghamshire border. In these ideal conditions they flower abundantly. Do not confuse oxlips with the more common false oxlips—hybrids of the cowslip and primrose. True oxlips have nodding heads which droop like those of cowslips, but their flowers grow all to one side.

Wood spurge is common in the damper areas of southern England and Wales. Like all spurges, it has separate male and female blooms; each single female flower is surrounded by several male ones. Wood spurge is hard to miss, even on a crowded woodland floor. Its brilliant yellow-green flowers contrast with its darker green leaves which taper where they leave the stem; there is sometimes a ring of them at the base of the top cluster of flowers.

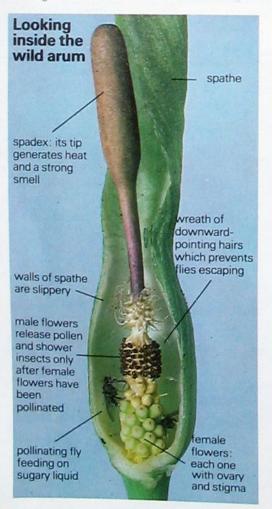


Lords-and-ladies

The sex life of the wild arum is a fascinating procedure and a most efficient way of ensuring cross-pollination. Insects, mostly dung flies, are attracted by the spadex's urine-like smell; 20-30 a day is a normal catch, but up to 4000 have been recorded. They land either on the slippery spathe walls or the spadex and, providing they are small enough, cannot help tumbling to the base of the spathe. The downward-pointing hairs at the top of the chamber prevent the quick departure of the flies, which may be trapped for several days.

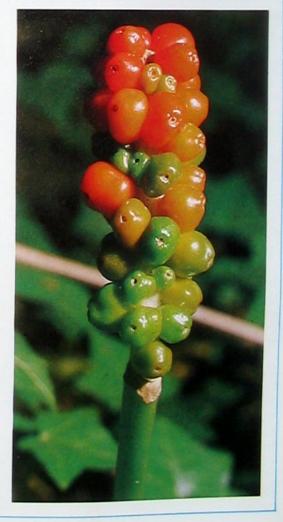
With any luck, the visiting insects bring pollen from another wild arum. This rubs off on to the stigma of the female flowers at the base of the spadex as the insects feast on the sugary liquid and try in vain to escape.

During the following few days the pollinated female stigmas wither and the male flowers above shed their pollen. (The male and female organs never act at the same time so self-pollination is impossible.) Meanwhile the hairs at the top of the chamber shrivel and the insects, dusted with fresh pollen, clamber out and fly off to another wild arum. So the process of cross-pollination begins all over again. Eventually the fruits ripen and the spathe and spadex collapse and disappear; so by autumn all you see are the bright red berries.





Above: Wild arum in April. The greenish leafy spathe unfolds about midday and during the following 8-12 hours the hot, club-like purple spadex gives off a strong smell. This attracts pollinating insects—mostly dung flies.



Right: By autumn all you see are the shiny, red, very poisonous berries which are the swollen female ovaries.

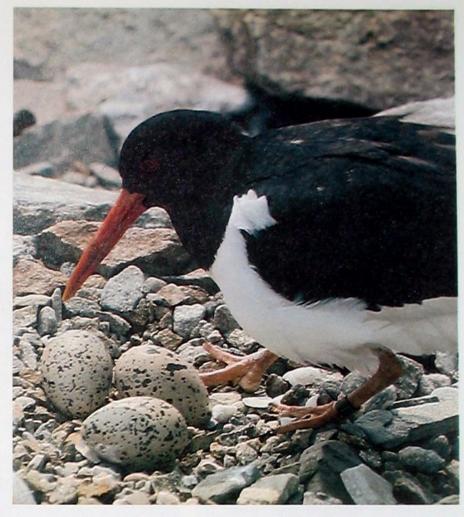
A NEST FOR EVERY SITUATION

A bird's nest can be just a scrape in the ground or an intricately woven cup, but it must protect eggs and shelter young from predators and bad weather.

Nests are the places where birds lay their eggs. But nests are not exclusive to birds: reptiles, fish, various insects, worms and other animals all make structures called nests. All these creatures make a nest for one good reason—to protect its contents. Eggs are fragile and need protection from breakage; they need warmth to develop and must not be exposed to bad weather; the eggs (and the young emerging from them) are particularly vulnerable to predators and must be guarded by the nest's construction and concealment.

Although a bird's nest always contains the eggs, it may not always house the developing young. Most small song birds, and some larger birds such as crows, owls and birds of prey, hatch out naked, blind and helpless and remain in the nest until they are ready to fly. Ducks and waders, on the other hand, hatch with their eyes open, with a covering of down and well-developed legs, and can scamper about or swim as soon as they have dried off.

Early in spring, or even during winter with larger birds, the male establishes his territory. Usually, within that territory there will be a number of suitable nest sites. With some birds, like the wren, the male does the bulk of the construction work on several nests, before the pair finally settles on one and puts the finishing touches to it. In the same way, the male lapwing will make several scrapes (by shuffling his feet and belly to produce a



Above: The eggs of the oystercatcher—perfectly camouflaged against the pebbles on the beach—need no extra protection.

Below: Nest and eggs of a red grouse; the long grass helps to hide the nest, but the eggs are protected mainly by the camouflage coloration of the hen.



saucer-shaped depression in the soil) before the final site is selected and a dried grass lining added.

With many other birds, it seems that the female plays the major role in selecting the actual site, and subsequently in building the nest. The male, however, does not idly watch his female dash back and forth with beakfuls of nesting material. He still has the vital job of guarding the territory, which demands continual alertness. The biological complexities of the breeding season become apparent: both birds must get themselves into the peak of condition—which means long hours of feeding—but at the same time territory must be secured and patrolled and the nest built.

Ground nests The simplest nests are those where the eggs are laid on the ground. Often, in such circumstances, protection from predators comes with the site; for example, guillemots nest on inaccessible sea cliff ledges. For others, such as the oystercatcher or ringed plover, birds which nest on a beach, the camouflage colours of the eggs provide the necessary concealment. Many wader nests look very simple–just scrapes in the ground–but they are in fact structured and in some cases ornamented; one nest contained over 1000 small pebbles, as well as twigs and pieces of shell.

Other waders, ducks and gulls make nests which are a further development of the simple



Above: Song thrush with young on nest. The cup shape of the nest stops the eggs rolling out and keeps the chicks safely in.

ground type. They gather dead vegetation, flotsam and jetsam into a mound and make a depression at its centre. The structures made by ducks and waders are usually at a low level, but the black-headed gull makes a built-up nest on the flat terrain of estuarine saltmarshes or moorland bogs, where the water level may rise suddenly and inundate low-lying eggs.

Game birds are also ground nesters and lay their eggs in grass-lined hollows. The hen protects her clutch from predators by her own camouflage colouring and will not budge from the nest unless it is absolutely necessary. Game birds do not have a strong scent, so predators like foxes find it hard to detect a red grouse or ptarmigan hen on a nest.

The floating nest is the next logical development. The little grebe's nest, loosely anchored to nearby vegetation, can rise and fall with the floodwaters and naturally survives far better than those of the coot or moorhen, which are fixed firmly in the reeds or on a low-hanging bough. For specialist swimmers like the grebes, which have legs set well back on a torpedo-shaped body, walking is awkward; floating nests are easier to get on and off.

Cup nests The cup is a practical shape for many purposes: the eggs cluster naturally in the bottom safe from disturbance and, if the nest is well constructed, safe too from the eyes of prying predators. Often the cup is lined with dried mud, fine grasses, moss, fur or feathers, which provide excellent insulation for the eggs; this also enables the incubating female to slip off occasionally to eat or drink. This insulation becomes more important when she has to help gather food for the young.

Right: Up to 12 chicks can be stuffed into the tiny, stifling, dome-shaped nest of the long-tailed tit. The nest is built of moss and cobwebs and is lined with countless feathers.

The basic structure of cup nests is the same, even when the size varies from the few centimeters in diameter of finches' nests to the one metre or more of those made by the heron and golden eagle. An outer framework of stout grasses, small roots, twigs or branches is lodged in a suitable tree fork or similar place. Gradually smaller and more flexible materials are tucked and woven into this structure, until the central cup is ready for lining. This nest is typical of the majority of perching birds - called passerines - which includes most small birds of farm, wood and garden. Where such birds extend their breeding range high up mountains or well to the north where there are few trees, similar nests are built on or close to the ground. Domed nests are elaborations of the cup

Domed nests are elaborations of the cup nest; additional protection is given by roofing over the structure and making a side entrance. Willow warblers build low-level grass nests of this type, while magpies construct high level, much bulkier versions. The most attractive examples are the long-tailed tits' cobweb-and-lichen, flask-shaped nests which are amazingly flexible to accommodate the



Nest boxes in the garden

One of the major problems for birdwatchers who wish to observe nesting behaviour is that birds try to make their nests as inconspicuous as possible. A nest box in your own garden gives you the opportunity to watch nesting birds at close quarters and in comfort. You can buy or make suitable boxes, or even put out an old kettle or an oil can.

Position the box high enough up a tree or the side of a house or shed so it is well out of reach of marauding cats (or children), but so that you still have a clear view. Make sure the box is not in direct sunlight or beating rain—you don't want the nestlings to overheat or drown. If you want to put up several boxes, position them at least 18m (60ft) apart, so different families do not disturb each other.

Once the box is in position, watch carefully to see which species of birds take an interest in it, and what nesting materials they use. The birds do not usually object if you want to look inside the box to check progress, but don't disturb a female sitting on eggs; watch for her to leave, then look but don't touch.

growing brood, and the better known dried leaf constructions of the wren. The male wren may build in any sort of crevice, from a tangle of ivy to an old jacket pocket in the garden shed.

Cavity nests Several birds, notably the owls, jackdaw and stock dove, nest in natural or man-made cavities such as hollow trees and church belfries. The house sparrow is a notable exploiter of cavities in buildings (although fully capable of building an untidy, domed nest outdoors). You might think these nests would be safer than other types, but this is not the case. The tit family are cavity nesters, but are vulnerable to attack from mice, woodpeckers and weasels.

Right: Suspended securely between reeds, the nest of the reed warbler is well hidden from predators and is so shaped that the eggs will not fall out even though the reeds sway in the wind.

Below: The great spotted woodpecker uses its strong beak like a hammer and chisel to excavate a nest hole high up the trunk of a tree where few predators will venture



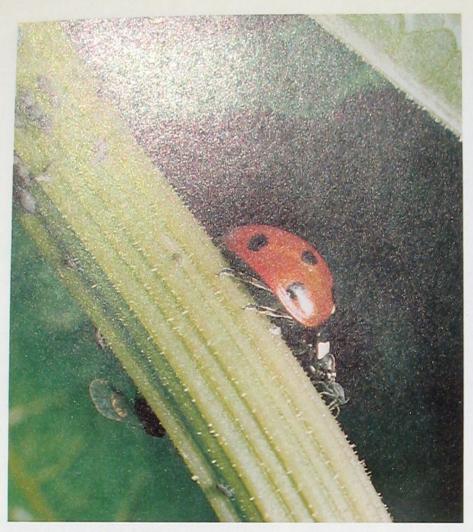


Other species, such as the woodpeckers, kingfisher and sand martin, excavate their own cavities in wood or the soil. Woodpeckers, which make a speciality of hammering and chiselling out nest cavities in tree trunks, are equipped with an extra pad of cartilage tissue situated just between the end of the beak and the nasal bone that acts as a shock-absorber, preventing the birds from developing a splitting headache.

Soil excavation is done with the feet and (sometimes) the beak. In sandy soils, some species produce metre-long tunnels ending in a nest chamber. The Manx shearwater and puffin—both seabirds—are also tunnel nesters. Both use natural rock crevices or oust rabbits from burrows in the cliff-top turf.

Suspended nests Perhaps the most sophisticated nests of all are the suspended ones. In the British Isles, the best examples are the woven mossy hammock nest of the tiny goldcrest and the basketwork nest of the reed warbler which incorporates supporting reed stems. This structure must withstand not only the movement of the reeds in high winds, but also (as the reed warbler is a common foster parent) the massive weight of a young cuckoo.

Exceptions to the rule In general terms it is possible to group nest types and relate them broadly to groups of birds and their habitats; but there are always exceptions. One example is the woodcock, which is a wader and would therefore be expected to nest on the seashore or in swampy moors and marshes; in fact it scrapes its nest on the ground in deep woodland. Another exception is the goldeneye—a duck, and therefore likely to nest on the ground beside water—which actually nests in holes in trees, often high above the ground.



LADYBIRDS: WELCOME BEETLES

Ladybirds, always popular for their bright colouring, are also one of the few insects welcome in the garden for the work they do in keeping down destructive aphids.

The familiar black and red ladybird is most people's favourite beetle. In the Middle Ages it was associated with the Virgin Mary and called 'beetle of Our Lady'; all our present-day names for this insect-ladybird, ladybug or sometimes ladybeetle-are derived from this medieval title. Today, ladybirds are welcomed by farmer and gardener alike for the valuable work they do in keeping down aphids.

Warning coloration The colouring of most insects is designed to help them remain concealed from predators, but the bright markings of ladybirds make them startlingly conspicuous. Strange though it may seem, this coloration is a protective device. Ladybirds

Above: The 7-spot ladybird, our commonest species, making a meal of an aphid. Ladybirds are voracious feeders and will turn up almost wherever there are aphids; a garden rose bush is a good place to search for them.

Below: 7-spot ladybirds mating. The male is the one on top; externally male and female ladybirds look alike. have a very unpleasant taste and they advertise this fact to their enemies through their coloration, which makes them instantly recognisable. A predator such as a house sparrow only has to eat a ladybird once to discover the unpalatable taste; thereafter it will leave others alone. Most species of ladybird are fairly similar in colour—they all gain blanket protection from looking alike. However, a few species, such as the red marsh ladybird (Coccidula rufa) and Rhyzobius litura which are a dull red-brown in colour and more elongated in shape than other ladybirds, seem to be the exceptions to this rule. No one really knows why this should be.

If you handle a ladybird, you'll find it exudes a few drops of yellow, strong-smelling liquid-actually blood-which stains the hand and smells pungent for quite some time. This, an example of defensive 'reflex bleeding', is designed to alarm and warn off enemies. Occasionally ladybirds will also bite and are quite capable of giving a sharp nip.

Common or garden species There are 45 different species of ladybird in the British Isles. Apart from their colour, you can distinguish them from other beetles by their short clubbed antennae and 3-jointed feet. With one exception, they are all carnivorous, feeding on a variety of insects, especially aphids. The exception to this rule is the vegetarian 24-spot ladybird which eats the leaves of clover.

The ladybird you'll find almost everywhere -fields, gardens, woods-is the 7-spot, which is red in colour with three bold black spots on each wing cover and an extra spot in the centre of its back where the wing cases meet. You should also be able to find 2-spot and 10-spot ladybirds fairly readily; both these species are red with black spots, but both can be very variable. In some individual 2-spot ladybirds, for example, the black marks 'run' to form patterns rather than spots, while in others the colours may be reversed so the insect is black with red spots. Some show melanism-darkness of colour-which is curious since in some other insects, particularly moths, it is a camouflage condition that





Coccidula rufa

Rhyzobius litura

appears to have developed in heavily industrial areas where dark forms could not easily be seen on soot-grimed trees and buildings. Ladybirds do not normally require the protection of camouflage colouring. Again, this is something which continues to puzzle researchers. Some 2-spot ladybirds even have extra spots, or can be black with yellow spots; these can be confused with the 22-spot ladybird which is always yellow with black spots.

Avid aphid-eaters Ladybirds often overwinter in communal groups. You can find them sheltering beneath loose bark on trees and in similar protected places, even indoors in the corners of window frames and doors. In spring, they fly in search of plants such as nettles or rose bushes which are infested with aphids. Here they feed, mate and lay their eggs. The eggs, usually deposited in batches of up to 50, are laid on the undersides of leaves.

The larvae which emerge from the eggs are quite unlike the adults; they are long, thin, grub-like creatures, generally dark grey with yellow or orange markings. In common with the adults, they have a voracious appetite for aphids; each larva can devour several hundreds of these unfortunate insects. After about three to four weeks of intensive feeding, the larvae moult to become pupae. The pupa case, similar in colour to the larva, is attached to a leaf by the tail. After one or two weeks in this transitional stage, the adult ladybird emerges from the pupa.

In Britain, ladybirds normally have only one generation a year. Eggs are laid by overwintered females which have mated either in the autumn or, more usually, after hibernation. Young adults spend the summer feeding or in a state of dormancy before hibernation. The complete life cycle takes seven to eight weeks

The year of the ladybird During the hot, dry summer of 1976 there was a ladybird population explosion in Britain. Swarms of 7-spot ladybirds were reported in towns and on beaches, with complaints that people were being bitten. Tests showed that some ladybirds were actually imbibing human blood, but most were drinking sweat to obtain water. The irritations were probably caused by reaction to the ladybird's own bitter blood, which gave some people a pricking sensation.

The build-up in numbers in fact began in the warm summer of 1975. Aphids were abundant in the spring and early summer but became scarce by mid-summer. This forced the ladybirds to travel in search of food. Many migrated to towns-increasing the population there by about 50 times its usual number-and remained there during the subsequent mild winter. They bred in huge numbers the following spring when, once again, aphids were plentiful. The population reached a peak in July 1976 when numbers were about 250 times the normal level.

Life cycle of the 2-spot



The eggs of the 2-spot ladybird are laid in batches on the underside of leaves. One female can produce several hundred eggs in her lifetime.



2-spot ladybird larva feeding on aphids. The larva will pupate after feeding for three or four weeks and undergoing three skin moults.



Pupae and one newly-emerged adult, whose wing cases take a few hours to harden and darken. The adult emerges from the pupa after about six days.

TEEMING POND LIFE

Ponds, with their clearly defined margins, are one of the easiest habitats to observe and understand. They are crammed with plants and animals, from masses of microscopic algae to roaming carnivorous fish.

It is difficult to highlight the characteristics of a pond since these mostly man-made areas of water vary so much in detail. From a biological point of view the important features are that they are all small areas of still water, little troubled by wind-generated waves beating on their margins and shallow enough all over for light to penetrate to the bottom to enable rooted plants to grow. Lakes, on the other hand, are too deep for rooted plants to grow in the middle, and are exposed to the full force of winds.

Water plants Apart from the truly aquatic plants such as algae that grow in profusion, pond vegetation consists mainly of representatives of widely differing families of terrestrial flowering plants that have colonised aquatic habitats, displaying differing degrees of adaptation to an alien environment. Examine the vegetation in and around a pond in summer and you will notice that the plants are not haphazardly positioned but occupy more or less distinct zones.

In the marshy area as one approaches a pond, among the rushes and sedges, will be found tall, lush plants such as great willowherb, meadowsweet, purple loosestrife, the bur-marigolds and yellow iris. They live not in water but in waterlogged soil, in which water instead of air occupies the spaces between the soil particles. The resulting scarcity of oxygen is compensated for by the spongy structure of the plant with many airspaces for the storage and passage of air.

At the edge of the pond, where the ground is covered with water except in times of drought, you find the second zone-the reedswamp community-named after one of the characteristic plants at the margin of larger ponds, the common reed. Most of the plants in this zone are tall and thus able to cope with changing water levels. Firmly embedded in the mud, their long creeping stems (rhizomes) keep the plants upright in high winds. Bulrushes or reedmace, bur-reeds, water plantain and the beautiful flowering rush are common plants of the reedswamp.

In the shallow water at the margins, sheltered by the reedswamp, is a community of plants rooted in the mud but with

floating leaves. Of these the best known and most beautiful of all water plants are the white and yellow water-lilies. Other plants in the floating-leaves zone are the various species of pondweed, water-crowfoot and fringed water-lily.

Further out, in the deeper water, are the totally submerged plants such as the watermilfoils, Canadian pondweed and hornworts. Although some are attached to the bottom, they are not dependent on the soil for their mineral nutrients as they can absorb both gases and dissolved salts from the surrounding water through their skin (epidermis) which is thin and delicate. Water plants, supported as they are on all sides by water, have no need for the strong, toughened stems of land plants. The submerged plants are the most completely adapted to an aquatic life and hornwort even flowers underwater, the pollen reaching the stigmas through the water.

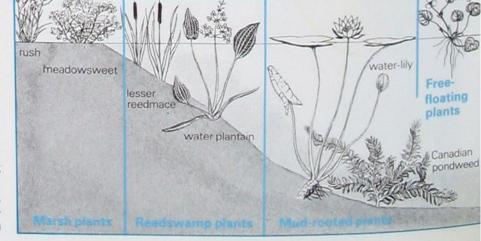
Independent of the bottom mud are the floating plants of which the duckweeds are the most common, often covering the whole surface of a pond with their tiny 'leaves', more correctly called thalli. Other floating plants are frogbit and bladder-worts, which trap small animals in the bladders on their leaves.

Finally, there are the truly aquatic plants, the algae, most of which are microscopic in size and either float freely as plankton in the water or are attached to higher plants or other objects. Spirogyra, however, and other filamentous algae, gather together in great masses and are clearly visible in the water as green cotton-wool. In spring these masses rise to the surface buoyed up by bubbles of oxygen, a useful reminder of the value of all green plants in the pond as oxygenators.

Animal life With all this richness of vegetation it is not surprising that the animal life of a pond is similarly abundant and varied. Representatives of nearly every main group from single-celled protozoans to vertebrates can be found. As with the plants, not all the animals are primarily aquatic: some are secondarily aquatic, that is as land animals they have adopted water as their habitat to

Above: A pond is not just an area of still, shallow water: it includes all the plants at the edges and rooted to the bottom which attract the wealth of creatures. Here you see the rare dark red Hampshire purslane and green floating pondweed in the foreground. Water-

lilies bloom in the shallower water, fringed by bur-reed and leaves of yellow iris.



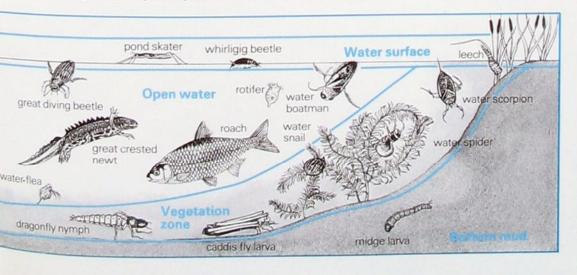


take advantage of the abundant food available. Some are herbivores feeding directly on the plants; others are carnivores. Among the secondarily aquatic animals are some of the snails, 11 orders of insects, some mites and one spider, the water spider. Although they live underwater, they have solved the problem of taking in air in varying and ingenious ways. Most beetles, for instance, have velvety piles of fine hairs on parts of the body which can hold a reservoir of air in a silvery bubble, thus limiting frequent journeys to the surface

to renew their air supply.

Pond animals live in four well-defined zones imposed on them by their particular way of life.

Surface film The surface of the water is in a state of tension and acts like an elastic skin, supporting small creatures both above and below it. The animals living on it are the least adapted of aquatic animals since they hardly ever descend into the water. These include a group of water bugs-pond skaters, water crickets and the water measurer. They feed on



Animal and plants zones

Most ponds fall into distinct animal and plant zones—ranging from the marshy margins to the bottom mud—which are described in detail in this article. The artist's impression, not drawn to scale, shows plant zones on the left and animal zones on the right, with free-floating plants and fish and crustaceans in the deeper water.



Above: Frogbit is one of the floating pond plants which do not need to root themselves in the mud at the bottom. The leaves of the frogbit are similar in shape to those of a water-lily but are considerably smaller.

Right: The great diving beetle lives in the vegetation zone and is a voracious carnivore. It preys on any small pond creature and, although only 3cm (1¼in) long, can even attack and kill roach.





Above: These water snails are probably feeding on algae which are attached to the water-milfoil. They respire through lungs and so have to surface frequently to take in air.

the abundant supply of dead and dying insects that fall on the surface during the warmer parts of the year.

Whirligig beetles also skim over the surface, but can descend below when hunting prey or when alarmed. The larvae and pupae of some flies such as gnats and mosquitoes use the underside of the surface film as a support when they surface to take in air.

Vegetation zone Here live the largest number of easily observed animals. Among the herbivores are the larvae of some species of caddis fly, which make their portable homes from pieces of leaf or stem. The caterpillars of the china mark moths also use the plants for making shelters as well as feeding on them. Neat oval holes, a few centimetres long, cut out of floating leaves betray their presence in a pond. Water snails are also plant-eaters but feed mostly on the algae, especially diatoms that are attached in great numbers to larger plants and stones.

Preying on all these herbivores are the carnivorous animals: several species of water beetle such as the great diving beetle; water bugs, including the water boatmen and the water scorpion; the nymphs of dragonflies and the smaller damselflies; and several species of leeches. Not all the leeches are blood-suckers; some, including the largest, the horse leech, swallow the whole of their prey.

Open water Away from the bank and marginal vegetation is the open water in which live both the largest and smallest pond animals—the fish and the planktonic crustaceans such as the water-fleas and the even smaller rotifers, which are seen with the naked eye only as a cloud in the water of a planktonnet, a fine-meshed net with a transparent glass tube at the bottom.

Some fish, such as the little 3-spined sticklebacks, are exclusively carnivorous and feed mainly on living animals. Others, including the roach, take both plant and animal food.

Bottom mud In this apparently unpromising habitat a surprisingly large population exists even if it consists of only a few species. The main problem is a shortage of oxygen which is used up in large quantities by the bacterial decomposition of the remains of animals and plants (detritus). On the other hand, there is abundance of food for animals that feed on these remains. Most common are the 'bloodworm' larvae of midges of the Chironomidae family. The red appearance of some of them is due to the presence in their blood of the same pigment, haemoglobin, that is in human blood.

In larger ponds there may be specimens of mussels, including the swan and duck mussels. They dig their fleshy 'feet' into the mud, open their jointed shells and take in large quantities of water through a siphon tube, extracting the oxygen they need and planktonic orgasms for food and then pass out the spent water through another siphon tube.

Pond visitors Ponds attract many animals either to drink, feed or clean themselves. Grass snakes swim in search of frogs and fish; water voles feed on the marginal plants; water shrews hunt for insects. Moorhens nest in the reeds, kingfishers dive for fish; swallows skim the water for insects, and house martins gather mud for their nests. These visitors play an important role: birds carry fragments of water plants and seeds, and sometimes aquatic animals and their eggs, on their beaks, feet or plumage from one stretch of water to another. So pond animals and plants become widely distributed.

SPOTTING SHELLS ON THE SHORE

Empty shells of all shapes, colours and sizes litter the beach and are fun to collect. Yet it is easy to forget that they once housed vulnerable occupants—supporting the soft parts of their body and protecting them against predators.

An empty prickly cockle shell lies stranded on the shore— its two valves clear-white on the inside, rough, yellowish-white on the outside. Normally the living animal is found in sand from 10m (35ft) downwards.

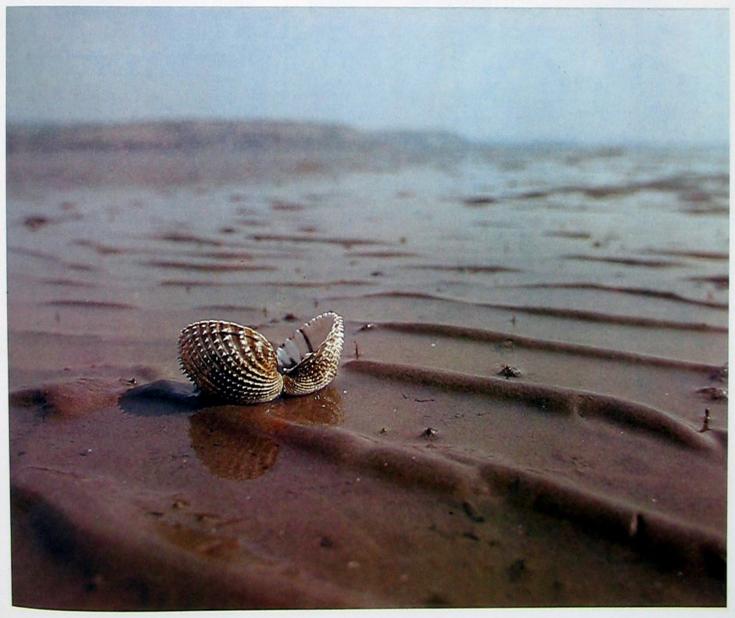
The shells you find on the seashore are normally empty, and they represent the end of the story because shells were originally the protective covering of living molluscs.

Molluscs are one of the largest groups in the animal kingdom-with over 100,000 species. Most of them live in the sea, but some have taken to the land (garden snails and slugs) and others to freshwater (mussels and snails). Of those which are marine dwellers, the majority are gastropods and bivalves. Although their body structure varies, they nearly all possess a shell. In gastropods this is a protective coiled tube, while the bivalves each have two rigid shells (valves), which enfold the soft body.

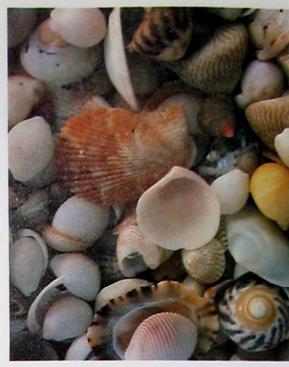
Inside the shell The outside of the body of all molluscs is covered with skin, part of which—the mantle—covers the region containing the internal organs. The outer surface of the mantle secretes hard crystals of calcium carbonate—not unlike a form of hard chalk—to make the shell.

In the snails and bivalves the mantle is folded to enclose a cavity (the mantle cavity), inside which lie the gills and the outlets for the excretory and reproductive organs. This mantle cavity takes up a lot of space as it encloses the greater part of the animal's body.

Some shells are lined with mother of pearl (as formerly used in high quality buttons) possibly to protect the soft organs of the body. If a grain of sand finds its way between the mantle and the shell, the mantle develops a small pocket around it. The lining layers then







isolate the source of irritation producing what we know as a pearl.

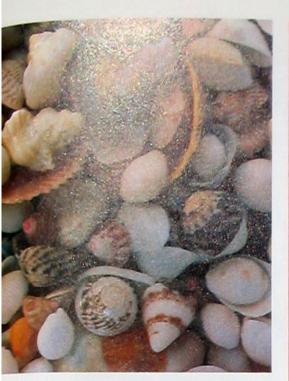
Growth and colour The concentric rings and lines, which you find on all shells, indicate the stages of growth. The rate of shell growth is uneven since, when food is scarce, the mollusc may use up all its energy to survive-rather than to develop. If the shell is damaged, the occupant makes its own repair by secreting calcium carbonate at the particular source of the damage. A crack can be made good in as little as 12 hours.

Special glands at the edge of the mantle produce colour in the outermost layers of the shell. The colours vary not only according to the particular mollusc's genes, but also according to water temperature, available sunlight and each mollusc's diet.

Bivalves The two valves are hinged together over the animal's back by a leathery, elastic ligament. A toothed hinge prevents one valve sliding sideways across the other. Many bivalves burrow in a vertical position, with this hinge at the top. As shown in the diagram (left) the bivalve has a foot below, a reduced head with mouth and oral palps at the right, and siphons at the tail-end on the left.

The valves may be equal in size and shape, as with prickly cockle shells, or unequal as with scallops. When a bivalve is feeding, the shells gape open; this allows the food-collecting siphon to protrude, and inhale a current of water bearing food and oxygen into the mantle cavity. Here the gills remove the oxygen and filter off the suspended food particles. 'Cleaned' water is removed by the exhalent siphon. When a mollusc is disturbed, it uses its powerful adductor muscles to pull the two valves tightly shut.

Gastropods The gastropod's mantle has developed in such a way that the single shell grows as a coiled tube, housing the body of the animal (see diagram right). In many



Above: Shells often accumulate in small corners and crevices to form 'graveyards'

Below: At low tide this edible winkle crawls over fucus seaweed which it feeds on.



species the mantle is able to produce special features in the shell, such as complicated patterns, or changes in surface ornamentation. Surface ornaments on the shell include points, lines and ribs.

The coiling process of the gastropod's shell is usually such that the shell appears to be built around a central column (columella), which may be solid or hollow.

In many species such as the periwinkles, a hard shelly or horny stopper (operculum) is carried on the animal's tail. When the tail is withdrawn into the shell, the stopper closes the aperture and defends the occupant against predators. It also prevents the snail's body drying up when exposed.

Later articles deal with individual species, as well as the cephalopods (squids, cuttlefish and octopus) many of which have an internal shell.

Some common gastropod shells



Dogwhelk (Nucella lapillus) To 3.5cm high on sheltered rocky shores: sharp point, thin lip. On exposed rocky shores 2.5cm, spine shortens and lip thickens.



Netted dogwhelk (Nassarius reticulatus) To 3cm high, thick shell; 15-20 strong ribs, 12-15 spiral lines on body whorl. On gravel.

Common whelk (Buccinum undatum) To 10cm high, thick shell, 7-8 whorls. In sand and mud; shallow and deeper water.





Common necklace shell (Natica alderi) To 1.5cm high; dark spots on body whorl. Sand burrowing.



Flat winkle (Littorina obtusata) About 1cm high, orange or dark green. On seaweed, rocky shores.





Edible winkle (littorina littorea) Ht 2cm, finely sculptured; no blunt tooth. Rocks, weeds.

Toothed top (Monodonta lineata) Ht 3cm, zigzag, purplish markings; single blunt tooth.



Common limpet (Patella vulgata) To 7cm long, greygreen inside with white-tobrown scar. On rocks and estuaries.

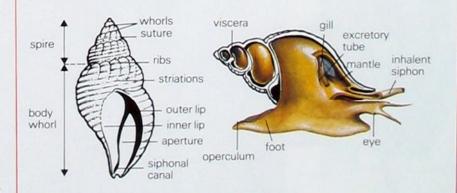


Purple top (Gibbula umbilicalis) Ht 1.3cm flattened top, green with broad red-purple stripes. Stones, rocks.

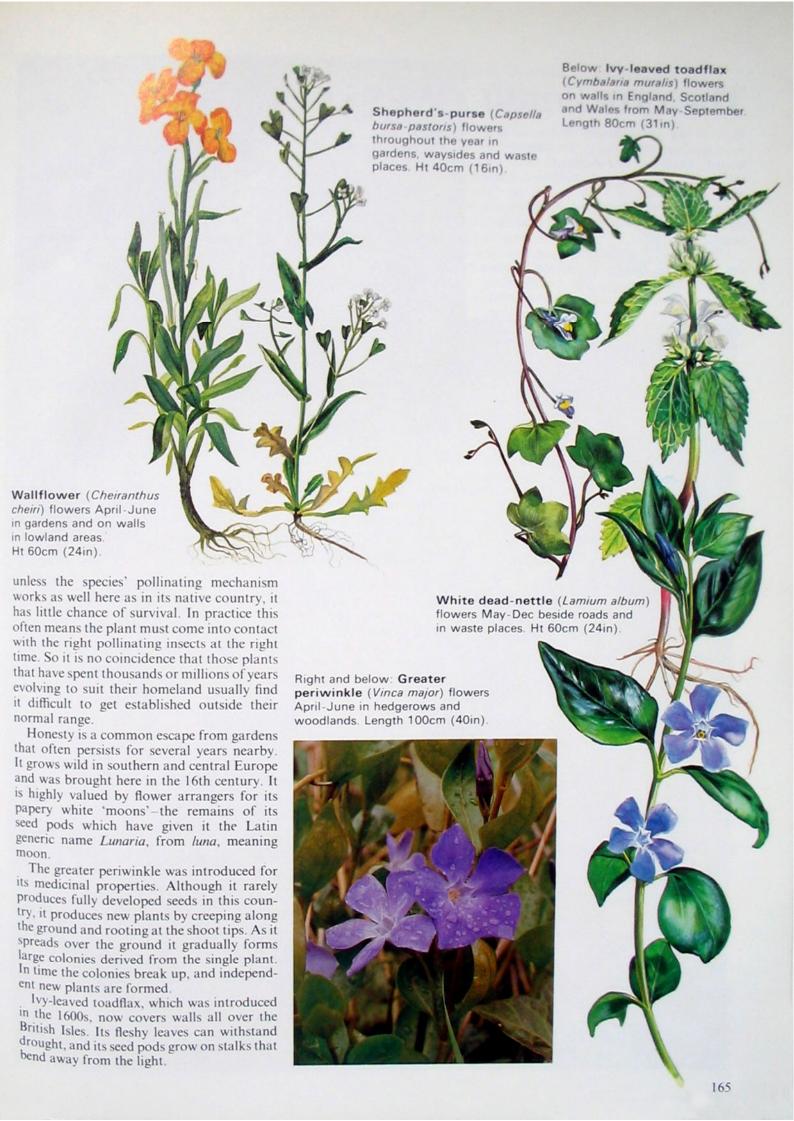


Grey top (Gibbula cineraria) Ht 1.2cm bluntly conical shell, grey with darker radial lines. Weeds, stones.

Naming the parts of a gastropod







The cruciferae

Most of the urban flowers illustrated here have obvious similarities. The flowers of honesty, wallflower and shepherd's-purse are, like the cuckooflower, each composed of four petals in the shape of a fat cross, hence the family name Cruciferae. Each flower has six stamens—four long and two short—and characteristic seed pods.

The Cruciferae (pronounced croo-sif-eree) is a large family. It includes garden aubretia and alyssum, and commercially grown mustard and rape, which provide those amazingly bright yellow fields in June; sweetly scented summer flowering stocks, and vegetables such as cabbages and radishes.

The flowers of this family all have the same basic structure (see below). They are grouped in spikes at the top of the stem and the flowers at the lower end of the spike bloom first. As the flowers mature and are fertilised, the spike grows, spacing out the swelling seed capsules and giving the younger flowers at the tip room for development.

Fruits The seed pod, like all fruits, develops after fertilisation of the ovules which lie in the centre of the flower. As the pod swells, the seeds ripen until they are ready to be shed. The pod usually splits into two from the base upwards, leaving the seeds attached to a

Cuckooflower or lady's smock (Cardamine pratensis) flowers April-June in damp areas. Ht 60cm (24in).

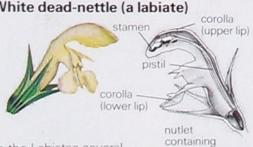
papery white membrane, the replum.

The 'moons' of honesty are particularly resplendant examples. Cuckooflower capsules split open violently, coiling as they do so, and the seeds are immediately shaken free of the replum and flung some distance. In other crucifers, like the wild radish, the pod does not split at all but breaks into segments, each containing a single seed.

Crucifer seed pods come in many shapes and sizes. In wild radishes they are elongated and indented between the seeds, showing where they will eventually break when ripe. Stocks and wallflowers have long narrow pods, in honesty they are flattened circles, and in shepherd's-purse they are heart-shaped.

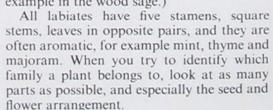
If you look at the white dead-nettle, a labiate, it is obviously not a crucifer. Notice its differently shaped flowers: instead of the four separate petals of a crucifer, a labiate has five petals, two are fused together to form the upper lip, and three form the lower lip. (Sometimes all five petals are fused to form the lower lip and the upper lip is missing—for example in the wood sage.)





seed

In the Labiatae several fused petals form the corolla. Its upper lip protects the reproductive organs, the lower lip is a landing platform.



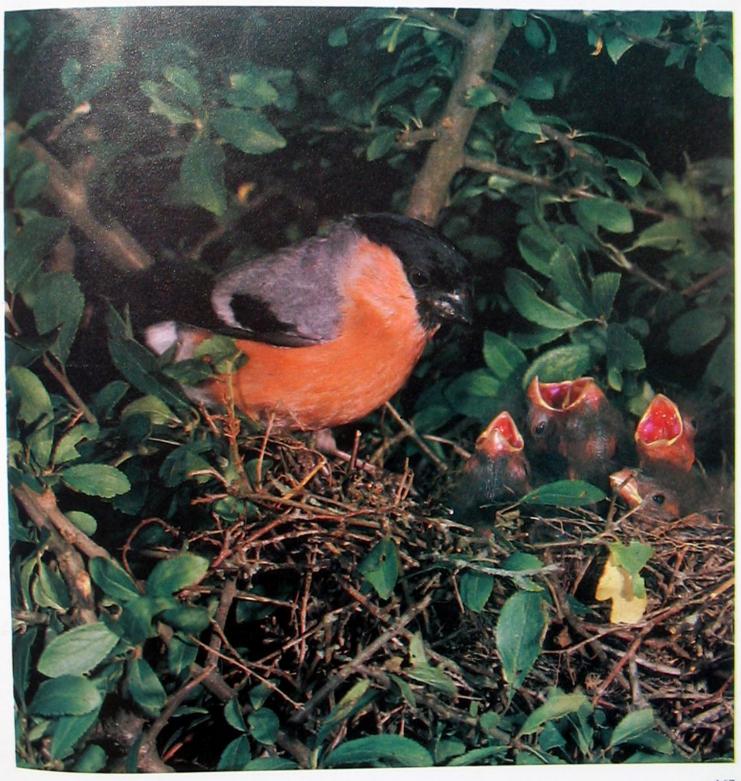


BULLFINCH: BEAUTY OR BEAST?

The bullfinch, one of our most beautiful garden birds, has a darker side, having earned a reputation as a wanton destroyer of buds on a variety of fruit trees. The bullfinch is one of our most colourful garden birds, the male's rose-red breast contrasting strikingly with its blue-black chin, cap, wings and tail. In spite of all this colour, however, it is easy to miss a group of feeding bullfinches. Usually all you'll see is a brief glimpse of a white rump flitting along a hedgerow or darting off into the thick cover of scrub or woodland.

Efficient foragers Woodland, especially coniferous forest, is the bullfinch's preferred habitat, but it is a versatile bird both in choice of habitat and in the food it eats. Only the most open land, lacking in bushes and hedgerows, seems to be too bare. A bullfinch rarely moves more than a few miles from

Below: Both male and female birds feed the young. The nest—a platform of interwoven twigs—is easily recognisable, but take care not to visit it too often as you may alert eager predators.



home territory and is expert at seeking out the best food available in its local patch—even to the extent of choosing between different varieties of fruit trees. In gardens and orchards it eats the buds of numerous bushes and trees, especially those of forsythia, apple, pear and plum. The short, stubby bill is ideally suited to this food; it can strip the hard outer husks off seeds and buds with very little trouble.

Adult bullfinches are vegetarians, though they feed their nestlings on large quantities of insects and spiders, which are predigested and then regurgitated for the chicks. As the young grow, the parents start to include seeds in their diet, increasing the amount gradually,

Half-a-tree-a-bird-a-day

Bullfinches eat buds at a horrifying rate. Calculations on fruit farms show that one bird can eat half the buds of a pear tree in a single day. In fact, this only takes about 1½ hours' feeding at a comfortable pace. Rates of 10 to 30 buds per minute are common, depending on the size and type of bud. Fortunately, most bullfinches depend on the seeds and buds of wild plants and only turn to fruit buds as the best alternative when wild supplies have failed.

At present there is no effective bullfinch deterrent which is economically viable. Assessing the cost of bullfinch damage is difficult, even when it is confined to single trees. Damage to plums and damsons is long-term, affecting the growth of the tree and, in subsequent years, the crop. Other fruit trees, notably pears and apples, can withstand substantial bud loss without loss of crop and, though damaged, often produce larger fruit.



until by the time the young leave the nest they are fed almost entirely on seeds. Throughout the summer and until late autumn bullfinches eat a huge variety of seeds—anything from minute grass seeds to the ash keys which hang in inviting bunches and are one of the bullfinch's favourite food.

From December onwards bullfinches eat tree and shrub buds; these contain next year's leaf and flower growth and are very nutritious. Unlike other finches, bullfinches don't have to search ground covered by leaves or snow to find fallen seeds or berries. They husk buds on the tree, leaving a scattering of litter which leads some people to think that they are vandals-destroying but not eating the buds. Many garden plants and commercially grown trees and bushes, cultivated for their early flowering or fruiting capacity, produce large flower buds that swell early in the year when the wild equivalents-hawthorn and blackthorn-are much smaller. Because of the damage done to orchards in southern England, the bullfinch has been removed from the protected bird list in some counties and many are now trapped or shot.

Busy breeding season The bullfinch is one of the many birds which overproduce young each summer to ensure that some survive winter to breed the following year. This is perhaps one of the main reasons why trapping and shooting, even on a large scale, does not seem to have affected the British population.





Above: The juvenile bird does not have the glossy black cap of the adult, nor the rose-red breast. By the end of the year, however, this bird's pale bill will have darkened and it will have a thick, waterproof coat of feathers to protect it through the winter.

Left: Male bullfinch in all the glory of full spring breeding plumage.

Most pairs of bullfinches rear two broods of about four nestlings a season; some pairs even manage to fit three broods into a nesting season lasting from late April to August or even September, despite the fact that over half the broods started do not survive. Efficient predators such as jays, magpies, stoats, weasels and cats often find even the best concealed nests and eat the eggs or nestlings. For this reason the bullfinch builds its nest-a distinctive platform of twigs bearing a cup of fine roots lined with hairin a thick, prickly, inaccessible bush or hedge. The pale blue eggs, dotted with reddish spots at the blunt end, are conspicuous. However, the hen bullfinch with body feathers in a combination of pink, grey, buff and brown, is well camouflaged for sitting on the nest.

Only the hen builds the nest and incubates the eggs. Incubation starts in earnest when the last egg is laid so that they all hatch together—usually on the thirteenth day. Both parents feed the young. While the nestlings are being fed, visits to the nest are kept to a minimum. The parents develop special cheek pouches in the summer and cram them with food to bring back to the young. They sneak silently into the bush together so predators don't follow them to the hidden nest. Because the cheek pouches hold so much food, the youngsters need feeding only every half-hour or so. The young spend 12-18 days in the nest. After this the adults abandon them

and start a new nest.

At this stage you can identify the young bullfinches by the absence of black on the head but from July onwards each bird moults, replacing all its fluffy juvenile body feathers.

Serenades and songs Bullfinches sing most often during the breeding season. Not many people have heard the song because it is very quiet-a soft, pleasant mixture of short, clear piping notes and hoarse wheezes which the cock seems to reserve for his mate. With feathers fluffed, head bobbing up and down and tail cocked to one side, he serenades her to secure the firm pair-bond necessary for successful breeding. More frequently you can hear the short, plaintive, carrying whistle which is used to contact others of the same species. This happens particularly in winter, when several birds-possibly a family partymay flock together where food is to be found. The call has many variations and is sometimes repeated three or four times as a second type of song. The finely tuned ear of the bullfinch can almost certainly recognise individuals by their particular accent-something which must be particularly useful when recently fledged young are still being cared for by their parents. From March onwards, except when the hens are incubating their clutch of eggs, you can often see bullfinches in pairs. It seems from the evidence of ringing that some pairs may well mate for life.

Bullfinch (Pyrrhula pyrrhula); length from beak to tail 15cm (5¾in); distribution widespread in woodland, plantations, hedgerows and gardens; absent from Isle of Man. Resident.

TELLING OUR SMALLEST MAMMALS APART

Small mammals are very secretive—they have to be to avoid predators. This makes them difficult to spot, even though they are much more common than we probably realise. Knowing where and when to find them is one problem; telling them apart is another.

There are ten species of mouse-sized land mammals living on the British mainland. These are the short-tailed field vole and the bank vole; the wood mouse, house mouse, yellow-necked mouse and harvest mouse; the common dormouse; and the common shrew, pygmy shrew and water shrew.

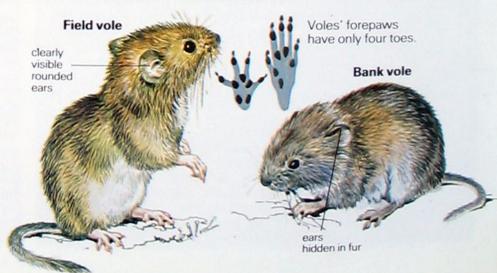
Ice-age ancestors Apart from the house mouse, which was probably introduced by man some 3000 years ago, all the others are true natives. That means their ancestors reached Britain after the last Ice Age but before the land mass was separated from the rest of Europe.

As the climate warmed, the mammals spread northwards from France into Britain-



Above: A yellow spot on the chest is enough to identify this wood mouse against the yellow-necked mouse, whose yellow area extends across the full width of the chest to form a collar.

Voles have blunt noses, short tails, with medium-sized ears and a rather plump shape. Field vole a little larger on average than the bank vole, which has a brighter chestnut-brown colour.



first the wood mice and pygmy shrews, which survive the cold better, and then the rest. Dormice, which need mature forests, would probably have arrived last. Since Ireland split from Britain before Britain was finally separated from the continent, only the first colonisers—wood mice and pygmy shrews—are native to Ireland. Early this century bank voles were somehow released near Limerick and are now spreading quite quickly in southwest Ireland.

The two voles, four mice and the common dormouse are all rodents-mammals with four curved, ever-growing incisor teeth for gnawing, and flat-topped grinding cheek teeth. There is a large gap between the incisors and the cheek teeth. The three shrews have continuous rows of teeth and are insectivores, although the water shrew also takes small fish and frogs. They are best distinguished from the rodents by their slender pointed muzzles.

Voles have rounded faces, short ears, small eyes and a tail that is no more than half the length of the head and body. Their shape helps them to live in burrows and to move along runways, hidden in the grass. Short-tailed field voles live exclusively in long tussocky grass and make runways under the grass just along the surface of the ground, nesting in the middle of the tussocks. Bank voles prefer hedgerows, scrub and burrows in gardens and woodland where there is plenty of undergrowth.

Short-tailed field voles have cheek teeth as well as incisors that keep growing throughout their life, to keep up with the rate at which a diet of course grass stems and leaves wears them down. Bank voles have cheek teeth that stop growing when they reach adulthood: since they eat seeds, berries and leaves, their cheek teeth do not wear down as quickly as field voles' teeth.

When voles run they scurry along the ground, whereas mice jump along like kangaroos using their long tail to help keep their balance when they are in a hurry.

Mice are much more omnivorous than voles, eating whatever is easy to find and so their diet changes with the seasons. Wood

Mice usually have sharp noses, fairly large eyes, and long tails. Yellow-necked mouse slightly larger than wood mouse, which has a brown top with contrasting white underside. Harvest mouse Harvest mouse very small; golden brown colour, house mouse grey or brownish. Dormouse bright golden-brown, fur close and plushy. Mice are good at jumping; their hind paws are larger than their forepaws. Wood mouse prehensile Common dormouse House mouse very long tail vellow mice, for example, eat caterpillars in May, collar fungi in autumn and seeds in winter. To cope with such a varied diet the cheek teeth are not flat-topped grinders but look more like miniature versions of human cheek teeth. Wood mice do not live only in woods. They breed on moorland, sand dunes, hedgerows, gardens and in crop-fields-and are also called long-tailed field mice (their tails are more than the length of the head and body together.) Their big eyes and ears-more prominent than voles'-help them sense danger when foraging Yellow-necked

Common shrew

Common shrew

Common shrew

Pygmy shrew

Shrews have five toes on the forepaws and on the hind paws.

Pygmy shrew

Pygmy shrew

Shrews are small, secretive; have long slender noses, tiny eyes, scarcely visible ears and close smooth fur. Common shrew medium-sized; pygmy shrew smaller with comparatively longer tail. Water shrew two-coloured, black and white.

Water shrew

for food at night. Sometimes wood mice climb mouse

bushes to find fruit, often using an old bird's

nest as a dining table and filling the nest with

bristles under tail and on feet to aid swimming

171

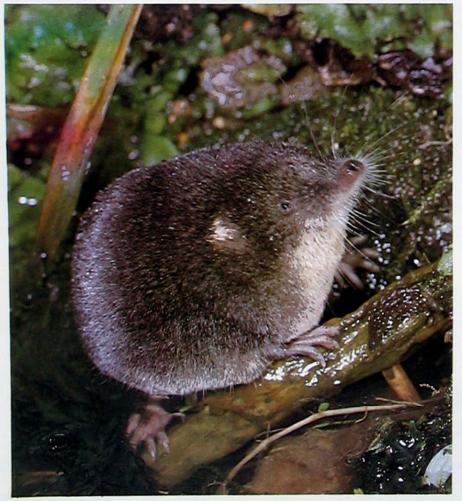


Above: An unusual feature of the common dormouse is the short downy fur on the upper surface of its feet.

Right: A juvenile bank vole tends to be darker and greyer than the adult. It is particularly vulnerable to tawny owls and weasels.

Below: Water shrews spend much time diving and swimming to catch aquatic insects. Sensitive whiskers detect prey underwater.





House mice are smaller, greyer and smellier than wood mice. They stay indoors most of the time, although in summer, when food is plentiful, they move out into fields. After harvest time they return indoors or go into barns and food stores.' They cannot survive the winter in the open, not because of the cold, but because of competition with the better adapted wood mice.

Yellow-necked mice can weigh up to 45g (1½oz), half as big again as wood mice. Their name derives from the broad collar of orange-yellow fur across the chest. They live mostly in mature woodland, in lowland, arable areas, especially those that are preserved for game, and are commonest in the south east and parts of the Midlands. In winter they often climb into houses and sheds in the country. Unlike house mice, which live and feed mostly in the kitchen, yellow-necked mice tend to live in lofts where they bring in food such as acorns from outside.

Harvest mice, the smallest mice, spend most of their time climbing around in tall grasses, reeds or the tall weeds on waste ground. They use their prehensile (grasping) tail to climb while they search for seeds and insects to eat. They are the only British species able to hang by the tail.

Harvest home The neat breeding nests of harvest mice, built 30-60cm (1-2ft) above ground, are made by weaving grass blades around plant leaves, especially in hedgerows. These nests are a sure indication of the presence of harvest mice; other small mammals' nests are not a good means of identifying particular species.

Before combine harvesters were used in corn fields, harvest mice were a common sight on corn stalks—especially when corn was cut by hand and stored in ricks. Nowadays these mice are more often found among scrub, long grass on roadsides, marshes and riverbanks. In the breeding season they suffer badly from wet, cold weather (it kills the young in the nest) and are therefore more numerous in the warmer, drier south and east of England.

Common dormice have two features which distinguish them from other mice—a furry tail and a total of 16 cheek teeth instead of 12. They are found only in woods where they spend spring and summer in trees or bushes feeding—in a similar fashion to squirrels—on nuts, berries, buds and a few insects. Because common dormice need deciduous woods, preferably with coppiced trees, they are more abundant in the south of England. Summer nests are usually built among tangled honeysuckle or in tree holes, but at many bird reserves these mice take advantage of nest-boxes.

Shrews Apart from the difference of classification, in that shrews are insect-eaters and mice are rodents, the most noticeable characteristic of shrews is the long, pointed nose. As well as insects, shrews also eat spiders, snails and woodlice, which is why they have a

long row of pointed teeth to grip and crunch their prey, instead of the gnawing and grind-

ing teeth of the rodents.

Common shrews are found where there is a dense ground cover—rough grassland, nettle-patches and hedgerows. Like all shrews, they are active day and night, winter and summer, as they have to feed every couple of hours or die of starvation. The smaller an animal is the higher the proportion of its food it has to burn up just to keep warm—and the more often it needs to eat.

These creatures defend their territory. Squeaking battles, as neighbours dispute their boundaries, often give away the presence of shrews hidden from view in the vegetation. Shrews have distasteful skin glands so, although cats often catch and play with shrews, they rarely eat them.

Pygmy shrews are the smallest British land mammals, each weighing a mere $3g(\frac{1}{8}oz)$ —compared with common shrews which only weigh 7-8g($\frac{1}{4}oz$), and mice which weigh about $20-30g(\frac{3}{4}-1oz)$. Although they live in the same places as common shrews and eat similar food, pygmy shrews are not sociable and will run away from any chance meeting with common shrews.

Water shrews—at about 15g (½0z)—weigh roughly twice as much as common shrews. They feed on land or in ponds and streams, preferring to catch aquatic snails and insects which they bring ashore to eat. Their fur is almost black, often with a handsome white underside and ear tufts. When they dive, the fur traps air to keep them warm and dry. Diving shrews are a beautiful sight because of the silver-like appearance given by the trapped air bubbles.

Lifespans Small mammal populations are at their lowest in April and May; winter has taken its toll and the breeding season is only just starting. After three or four litters of young have been born through the summer, the old adult animals die—usually from hunger—or are killed by predators after being displaced from their territories by the large numbers of new youngsters.

The young which survive the winter start the cycle again. This means the normal maxi-

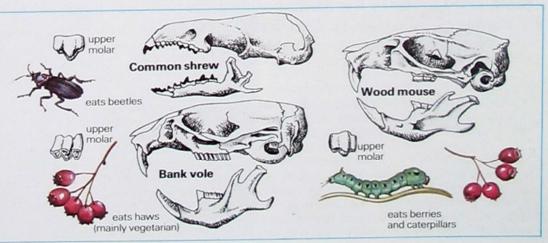


mum life for a small mammal in the wild is just over a year. The exception is the dormouse, which can live for three years—but it spends half its time hibernating. It seems that the lifespan of most mammals is related to the speed at which they live. A shrew's heart beats about as many times in its year of life as an elephant's does in its 50 years. A hibernating dormouse, however, slows down its heart rate and lengthens its life. Most small mammals are perpetually alert and active.

Later articles deal with each of the above species, and also with those small mammals that are found only on some of the Channel, Scilly and Orkney Islands. Harvest mice live in reedbeds and other rough grassland, but they have also taken advantage of cornfields which man created—as this balancing harvest mouse demonstrates. However nowadays combine harvesters make corn stalks a precarious haven.

Skulls and teeth

The type and arrangement of mammals' teeth gives clues to their diet. A long row of pointed teeth helps shrews catch hold and crunch insects. Voles and mice are rodents: their ever-growing incisors are kept chisel-sharp by gnawing—the hard front of the tooth wears slower than the back. Cheek teeth are used for grinding. Voles are vegetarians and have flatter topped cheek teeth than the omnivorous mice.





BLOSSOM TIME IN THE ORCHARDS

Orchards in spring are a dazzling drift of blossom

from the lichened cider apple trees of Devon, the
plum plantations of the Midlands and the rows of
tall cooking-apple trees in the Fens to the neat ranks
of apple and pear trees in the south east.

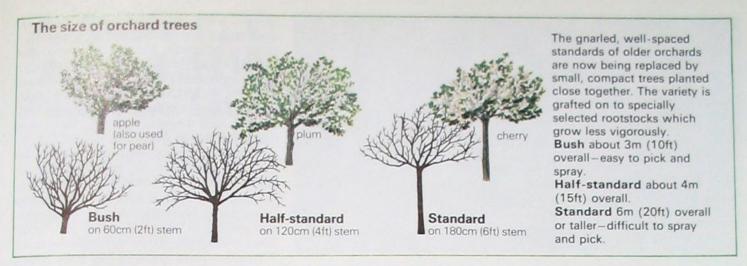
From April to May each year some 100,000 acres of English orchards come into flower. The first tree to flower is the plum, followed by the pear, cherry and apple. All these can be seen in turn in the major fruit-producing areas of Kent and Sussex. In Essex and Suffolk the main contributor to the show of blossom is the dessert apple. Plum blossom is of special interest in Worcestershire and Warwickshire, where thousands of visitors

throng to the plum tree parishes in spring. There are also sizeable areas of plums to be seen in blossom in Norfolk, Cambridgeshire and Gloucestershire. In Herefordshire, Somerset and Devon there is a special emphasis on perry pears and cider apples. But behind the lovely mass of blossom lies a great deal of hard endeavour.

Apples occupy the largest acreage and are usually grown on the same farm as pears. If you draw a line on a map linking the Bristol Channel to the Wash, the majority of apple and pear production lies to the south east. The reasons for this are partly historical. Over the centuries invaders and other visitors from the Continent brought improved agricultural techniques to this area and monasteries, castles and large homes near London often had their own orchards.

Attempts to grow dessert apples, and particularly pears, commercially further north and west of this area have not always been successful because of the climatic limitations.

Soil and site Whatever the district, all fruit trees need well-drained, deep soil; so you do not find orchards on thin chalkland, heavy stagnant clay or gravel. The site is



Left: A typical orchard of bush apple trees, with a small area under each tree kept free of competing weeds by the careful use of herbicides.

equally crucial. It is unusual to find orchards above an altitude of 100m (400ft) and there are few to be seen at the bottom of valleys.

High ground is likely to be windswept and the soil eroded by centuries of rainfall. The valleys, where the soil may be deep as a result of erosion from the land above, are vulnerable to spring radiation frost-particularly dangerous to fruit crops. On clear, cold, windless nights there is no cloud cover to prevent the loss of heat radiated from the ground. As the warmer air rises the colder, heavier air flows downhill into the valleys, so blossoms on trees in low-lying places freeze, while fruit crops on land which is higher-but not too high-escape the frost.

The most efficient fruit farms are therefore on good soil, on gentle slopes, with reasonable shelter from prevailing winds. It is sometimes difficult to find the perfect combination, and many growers on less than ideal sites have to protect their trees from devastating spring

Spring frosts It is now too expensive to burn oil; but if you are in a fruit-growing district in spring, you may see an astonishing sight at dawn, after a frosty night. Acres of trees may be covered with long icicles-the result of continuous sprinkling with water.

At first glance this may seem a strange thing to do, but the technique is based on a beautifully simple piece of physics. When water is changed from the liquid to the solid state, heat is released; if this slight increase in temperature can be, as it were, trapped close to the blossom, the internal temperature is kept above the critical level at which cell destruction occurs.

Pollination Springtime, so pleasing to most of us, is an anxious period for the grower. Even if the blossom escapes frost damage, it must be pollinated and the ovules fertilised before the fruit will set. Some varieties set fruits with their own pollen. But for all practical purposes most tree fruits, except some varieties of plum, will not produce full crops unless they are fertilised by pollen from another variety.

Insects, mainly bees, are the chief pollinators, and bumble bees are the most active natural pollinators of all. They work fast, and from the grower's point of view they are very welcome because they forage during cold weather. But there are just not enough of them to cope with the spring profusion of blossom. The grower therefore introduces hives of honey bees at a minimum of one large colony, which may contain up to 15,000 bees, per acre and arranged in groups to encourage a wider flying range.

Bees are fascinating creatures, and honey is delicious. But it is an odd paradox that the sophisticated technology of modern fruit growing should be dependent on such unpredictable agents. It is likely that before long the effects of pollination, which result in the formation of seeds and fruits, will be achieved by using synthesized plant hormones. But

that time has not yet been reached.

Plums, and their close relatives damsons, are more tolerant of colder climates and can be grown successfully further north on heavier soils. The plum orchards of Worcestershire and Warwickshire are particularly attractive in early spring, but all too often the brave

Apple blossom, showing the first opened flower, known as the 'king'. Only one flower in each cluster is likely to produce fruit. Apple flowers can be distinguished from other fruit tree blossoms because they are usually pink in bud and in flower.



Right: Plum blossom. You do not see so many intensively planted plum orchards as you do with apples and pears. Most plum orchards still consist of the traditional half-standard trees.

Below: Pear blossom that has been sprinkled with water during a spring frost. When water freezes it generates enough heat to prevent the destruction of the delicate reproductive cells.







Left: Cherry blossom several varieties of sweet cherry and one acid cherry are grown in England. Birds flock to devour the summer fruits.

show of white blossom is not followed by a satisfactory harvest. In fact the plum crop tends to be erratic, fluctuating between glut and scarcity. The main problems are early flowering and cold springs and the consequent failure of the fruit to set; bird damage to buds during winter—the main culprits being bull-finches; and disease, especially the fungus disease known as silver leaf.

Research workers are now looking for later-flowering varieties, improved and acceptable methods of bird control, and possibly even the control of silver leaf. One idea being pursued is to introduce another fungus antagonistic to silver leaf and so prevent the silver leaf organism from gaining a foothold.

Because plum growing has been largely unprofitable there has not been the same trend towards the intensive planting that you find with apples and pears. Generally plum orchards still consist of the traditional half-standard trees, designed to prevent heavily laden but slender branches touching the ground.

Cherries offer a contrast. There are two distinct types grown. The better known sweet cherry grows on magnificent full-standard trees, perhaps planted 12m (40ft) apart, sometimes with sheep grazing beneath. This is the most demanding of all fruit trees and can only be grown satisfactorily in the deep brick-earth soils, largely in Kent. Starlings and other fruit-eating birds flock from miles around, so sweet cherries must be grown in large enough units to justify scaring devices and ensure enough fruits for both birds and growers. The odd explosions you can hear in cherry orchards are in fact from 'cannons' used for this purpose. The other cherry, the acid Morello, is grown on small bushes and the fruits used for processing.

Pests and diseases An orchard full of pests may be a paradise for the naturalist, but it is a disaster for the grower. If pests are supplied with apparently limitless host plants, they multiply speedily and often outstrip natural parasites and predators. In a neglected orchard the leaves may be pale and dispirited, because the juices have been sucked out by mites and aphids, or are tattered as the result of champing colonies of caterpillars. Shoots may be crippled by mildew, and the fruits invaded by maggots or scab fungus.

The secrets of successful fruit growing is to work with nature to produce healthy crops, which in practice means the careful use of chemicals to protect the trees during the growing season. This ensures that as far as possible the beneficial insects in the orchard are unharmed.

The future for fruit growers as a whole presents problems as they strive to increase both production and income to keep pace with rising costs. The major factors include the cost of labour, particularly for pruning and picking, suggesting further mechanisation, and the use of growth control agents.

CADDIS FLY: A CASE FOR PROTECTION

Caddis flies spend most of their life in the larva stage. They build up an elaborate form of protection to survive the attentions of predators during this year-long period.

Caddis flies, known to anglers as sedges or rails, are common insects in ponds, lakes and streams throughout the British Isles, where there are nearly 200 species. Most are difficult to see. They flit about at dusk and can easily be mistaken for small, brownish moths; in the daytime they hide in waterside vegetation and rarely feed.

They are an important link in the freshwater food chain since a great many fish and water birds feed on both adults and larvae. Since the larvae, with soft, caterpillar-like bodies, make easy meals for predators, protection is vital. Still and slow-moving water species build cases out of surrounding materials, while others—those in fast-flowing streams—weave silk nets.

Self-protection There are as many as eight different methods employed by case-building larvae to make their cases, but all involve the cementing together of sand, bits of vegetation or empty shells, using silk produced from a special gland near the mouth. Each species favours different materials and makes a case of a recognisable pattern. The larva attaches itself firmly to the inside of the case with a pair of hooks situated at the tip of its abdomen. It breathes underwater by means of feathery gills, undulating its body inside the case so a current of water passes over the gills. The head and legs protrude from the case so the larva can move in search of food. Case-builders are vegetarians.





Net-making larvae, which are generally carnivorous, spin themselves a net and attach it to the underside of a stone. The larvae of the Hydropsyche family, common in fast-flowing streams, position the net so its open end faces upstream. Small animals are snapped up by the larvae, sitting inside the net. Members of the Rhyacophila family are free-living, tougher-bodied, predatory species.

The larval stage lasts about a year. When the time comes for pupation, the larva seals itself inside the case and cements it firmly to a submerged object. Non-case-building larvae pupate in a silk cocoon inside a specially made chamber of sand. When it is ready, the pupa bites its way out of the case and crawls or swims actively to the surface, where the adult finally emerges.

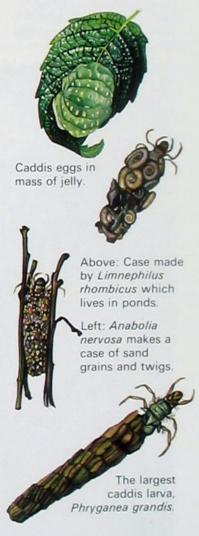
Breeding Male and female mate while resting on a plant. The eggs are laid in a gelatinous mass—either on overhanging leaves or, in running-water species, on stones or vegetation under water—and hatch in 2-3 weeks.

Adults emerge in great numbers throughout late spring and summer. On rivers and streams in April and May you might see female greentails (*Brachycentrus subnubilus*) carrying a large oval cluster of bluish-green eggs at the end of their abdomen; or perhaps the reddish-brown Welshman's button (*Seri*costoma personatum), one of the few species to fly about in daylight. The lifespan of the adults is short—lasting only a few weeks.

Left: Caddis larva with case of twigs and plant debris; lives in slow-moving water and drags case with it as it looks for food.



Above: Adult caddis fly; it holds its two pairs of wings above the body when at rest. Note long, slender antennae.



WALK INTO THE WORLD OF A BLUEBELL WOOD

Below: In May, before the shade cast by the trees becomes too dense, bluebells flourish among other flowers, grasses and bracken. You will often find them under oaks such as these in the woods of Wakehurst Place in Sussex. By June the flowers start to die down and the leaves begin to rot. Bluebells are widespread throughout the British Isles except for areas around the Wash,

north-west Ireland, Nairn and

Morayshire.

For only three weeks in the year can you catch sight of a magnificent blanket of vivid blue covering the ground in many deciduous woods. This is created by thousands of bluebells which only grow in such profusion in the British Isles.

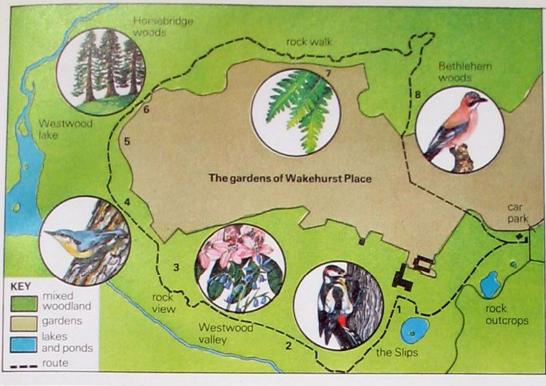
Often they indicate pockets of ancient woodland.

There can be little to beat the splendid blue ground cover of a bluebell wood in full bloom. The bluebell can grow in the darkness of woods because it has underground bulbs by which it propagates itself each year. However it prefers light, well-drained sandy or clay soils in birch, oak, hazel, coppiced or mixed woods. You may also find it along hedge

banks, rides and clearings. (Don't confuse the bluebell with the harebell, which is referred to as the bluebell in Scotland. The harebell grows in more open areas such as downland and sandy sites; its flowers are larger than those of the bluebell.)

Bluebells are typical of most woods in the Kent and Sussex Weald area, and one of the





Bluebell Walk

Wakehurst Place in Sussex is on the B2028 between East Grinstead and Haywards Heath. Open 10am to 7pm daily; £1 for adults, 50p for children. Picnics are allowed but dogs are not. There are many wellsignposted walks and the one we have selected, the bluebell walk, covers about 1½ miles. Walking at a leisurely pace this will take you about an hour, but you can easily short-circuit the walk if you have less time to



best sites open to the public is Wakehurst Place. The 16th century house, with its 470 acres of land, used to be owned by the Culpepers—of herbal fame. Now it is managed as an extension of Kew Gardens by the Ministry of Agriculture, Fisheries and Food, on lease from the National Trust. There are over 100 acres of bluebell wood to visit in the well-managed woodland. A feature of the grounds is the many different types of habitat—deep sheltered valleys, open slopes and rocky outcrops—where a great diversity of flowering plants grow.

The walk set out here starts from outside the south-east end of the house by the pond. You pass downhill (1) through the rock outcrops and gardens of the Slips into Westwood valley. As you go down the hill there are several large beech trees which were planted early this century. Turning right after the Slips (2) in the direction of rock view listen for the drumming of the great spotted woodpecker, which has bars of black and white on its back. You may catch sight of one—or of a green woodpecker—excavating a hole quite high up in an old tree trunk. They use these holes for nest sites, and avidly probe beneath the bark with their pointed beaks for insects.

The white garlic-smelling flowers of ramsons (wild garlic), still used as a flavouring in West Country cheeses and stews, grow well here as they prefer the wetter areas of woods.

As you pass beyond the rock view (3) take note of the fine spread of bluebells under the rhododendrons. Here the flowers are mixed with bramble, honeysuckle, bracken and ferns. Look too for the wood sage and spurge growing alongside the bluebells. You often find bluebells mixed with bracken and creeping soft-grass as well. The three species can co-exist in the same area without any com-

petition for soil nutrients as they have roots which go down to different depths. Other species of plants associated with bluebells are the common violet, common tormentil, wild strawberry and early purple orchid.

Notice as you walk through these woods how the trees are managed so that much of the dead wood is removed for safety reasons. This is in contrast to what happens in the Loder Nature Reserve opened recently at Wakehurst, which you can visit by written application to Wakehurst Place. There old wood is not cleared away as it forms an important habitat for insects, molluscs, fungi and small animals.

Along the upper path (4) above Westwood lake look out for the blue-grey nuthatch. It also uses holes in tree trunks for nests, but you can recognise the nuthatch's hole from the woodpecker's by the compressed mud around the entrance which leaves only a small gap for the parents to go through. You may also catch sight of the light brown treecreeper, searching for insects on the bark of trees.

The openness of this part of the wood allows such tall plants as foxglove and willow-herbs to grow among the bluebells and white-flowered wood anemones. Notice how the three leaves of the wood anemone are divided and grow half way up the flower stalk.

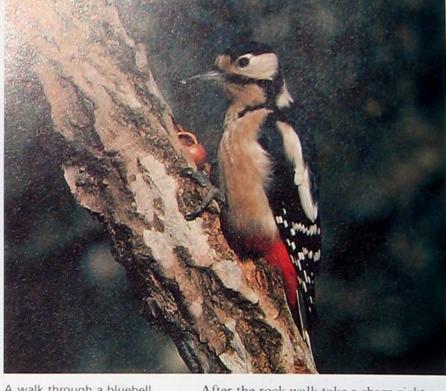
At the top of the hill (5) a different group of plants grow together, including yellow archangel, the delicate white flowers of greater stitchwort mixed with bracken and bluebells, all species collectively signifying an ancient (relic) wood. You should also come across albino bluebells here. They are usually found in all bluebell woods, probably in the ratio of 1 in every 20,000, and are caused by a gentical fault in the pigmentation. Watch the

insect pollinators, the bumble bees and to a lesser extent the honeybee, busily working the bluebell flowers. The big black blobs of bumble bees can be seen from quite a distance. Both the bumble bees and honeybees obtain their nectar, a sugary solution secreted at the base of the petals, by pushing their tongues right into the petals.

In Horsebridge woods (6) look for two pairs of exotic redwood trees, both of which are evergreen and very tall. The coast redwood is the tallest species in the world, reaching 110m (360ft) in California. The wellingtonia reaches 50m (165ft) in Britain. As the two species are quite similar, check the labels for identification.

The rock walk (7) provides an excellent opportunity to see a variety of different types of mosses, ferns, liverworts and lichens, which thrive in these damp, dark conditions. Dampness is essential for liverworts in particular, as they must be covered with a film of water in order to reproduce. Lichens, seen here growing on the weathered rocks, can be found in great variety on tree trunks.





A walk through a bluebell wood in early summer can reveal all sorts of wildlife. You might come across a clump of albino bluebells (below) or spot a bumble bee (left) sucking nectar from the flowers. The great spotted woodpecker (above) clings to tree trunks with sharp claws, chiselling into the wood to get at the larvae of beetles and moths. It can survive in the woods through the winter by supplementing this invertebrate diet with whatever nuts it can find.

After the rock walk take a sharp right and enter Bethlehem woods (8). Here you can see a variety of rhododendrons and, covering the ground, bloody crane's-bill. You may disturb a few woodpigeons searching the ground for last year's acorns or a jay, which can be recognised by its bright flashes of blue, black and white on its wings and by its distinctive screeching call. After Bethlehem woods follow the exit signs around the old walled kitchen garden back to the car park.

If you are walking through any bluebell wood keep an eye out for the well-defined tracks of badgers criss-crossing the bluebells. Badgers are very particular about where they walk and members of the same group always use the same paths. Where badger setts and foxes' earths are in use, as they will be at the end of April with the young venturing out, the bluebells will be flattened where the animals play. Badgers digging for earthworms or pheasants turning the soil for insects might expose the white bulbs. These bulbs, which provide the energy needed by the growing plant, cause the plant to double in weight by mid-April and to treble in weight by the beginning of June.

The speckled wood butterfly is another inhabitant of bluebell woods. It has the habit of 'claiming' shafts of sunlight in the wood and vigorously defends its position against rivals. It also frequently suns itself on bramble leaves, imbibing nectar from flowers or occasionally spiralling upwards through a shaft of sunlight, contesting with another speckled wood until one of them flies away defeated.



A number of other spectacular bluebell woods around the country will be listed in the 'Country Matters' section of Issue 10.



CUCKOO: THE NEST SQUATTER

The cuckoo, whose call is so familiar in early summer, comes here to breed, but it neither builds a nest nor cares for its young—other birds do that for it!

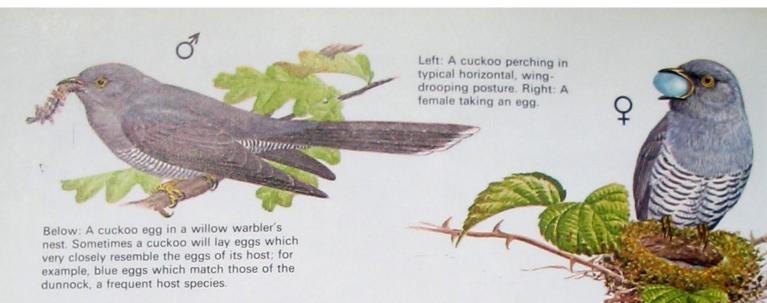
The cuckoo is frequently heard but, being a shy bird, is seldom seen. The one British breeding species is extremely vocal from the moment it arrives here from Africa in mid-April. It sometimes calls on the wing, but usually waits until it alights before uttering the familiar, far-carrying 'cu-coo'. Occasionally the cry is 'cu-cu-coo' which, with other

variants (and contrary to popular belief), can be heard at the start of the season as well as near the end. A much lesser known call is a comparatively subdued liquid bubbling sound. It is likely that most of the 'cu-cooing' comes from the male and most of the bubbling from the female, but both sexes can make these calls. Both also use a deep 'growow-ow' sound. Strangely enough, cuckoos often seem to call with their beaks closed.

The only view you're likely to have of a cuckoo is as it hastens by on a direct, level course, its rapidly beating wings held mainly below the body, or as it glides the last few yards to a perch. It is a long-tailed, hawk-like grey bird with barred underparts and bright yellow eyes, and often perches horizontally with wings drooping. Cuckoos' feet, which have two toes pointing forwards and two pointing backwards, like those of a parrot, are adapted to make perching and scrambling about in branches easy, but it makes the birds clumsy waddlers on the ground.

The cuckoo is insectivorous, feeding on the

Above: A young cuckoo about two weeks old.
Juveniles are often reddish in colour and can be further distinguished by a pale patch on the nape.
Occasionally, when two cuckoo eggs have been laid in the same nest, the foster parents find they have two chicks to rear because neither has succeeded in evicting the other.





caterpillars of magpie moths and the larvae of sawflies and other insects; it is also unusual in being an avid devourer of hairy caterpillars and brightly coloured ones which warn of an unpalatable taste—insects normally avoided by birds.

Take-over bid The breeding season begins as soon as the cuckoos arrive in Britain. The males display excitedly, sometimes several of them together: calling loudly, they sway from side to side, bobbing up and down and even spinning round, their large, decorative tails raised and fanned out.

While the males display, the female cuckoo keenly defends her own territory, at the same time observing possible host species-birds smaller than herself such as willow warblers, meadow pipits, dunnocks or even robins. Her aim is to find out where they are building and when they start laying their first eggs. After days of careful watching, the female chooses a nest with an incomplete clutch of eggsusually with just one egg-where incubation has not yet started. Between mid-afternoon and eight in the evening-a time when her victims are likely to be away feeding (because their eggs were laid in the morning)-the female cuckoo flies straight to the nest, ignoring any small birds which mob her in mistake for a hawk. She takes an egg out of the nest and holds it in her beak while she quickly lays one of her own in its place. Finally, she eats or discards the egg.

Cuckoos' eggs have been found in the nests of over 50 different British birds. Some of these nests-such as the hole type-seem rather unsuitable. Where the nest is in a hole too small for the cuckoo to enter, she clings with outspread wings and tail against the opening and ejects her egg into the nest. If this fails and her egg rolls aside she abandons it, making no attempt to pick it up.

Most small birds lay an egg a day, but the cuckoo lays every second day, presumably to give herself time to find all the nests she needs, for she may lay a dozen or more eggs. When her final egg is laid the female cuckoo's task is over, and she takes no further part or interest in her progeny's future. Nor does the male. He stops singing by the end of June and then he, and all other adult cuckoos, are free to fly back to Africa. They leave in July, the earliest of our summer birds to go.

Fooling foster parents An intriguing feature of the story is the foster parents' generally willing acceptance of the cuckoo's egg. Occasionally the put-upon fosterers react by burying the alien egg under a fresh layer of nesting material; a very few species, such as the blackcap and the spotted flycatcher, seem to have become cuckoo-resistant, readily deserting the nest if a cuckoo lays her egg in it. Most cuckoos avoid the nests of these species. The female cuckoo's biggest risk is that her egg may be rejected. Perhaps her main reason for removing an egg before depositing her own is to minimize suspicion in the fosterer's mind. Sometimes two or even three cuckoo eggs are found in one nest, but they are almost invariably laid by different birds-something which is easy to check since the eggs of each cuckoo are individually marked and can be recognised from year to year.

Whenever possible a female cuckoo, all her life, lays in the nest of only one kind of host species. The females are grouped into various clans—such as the meadow pipit cuckoos (probably the commonest clan in Britain), hedge sparrow cuckoos (mainly in woodlands and hedgerows) and reed warbler cuckoos (in aquatic habitats). Such fixations seem to go back to the cuckoo's earliest days: a meadow pipit cuckoo is one which was born in a

Above: A newly hatched chick ousting the host's egg from a nest. The instinct to do this is very powerful and lasts for about four days.

Migration route

Adult cuckoos leave in late July, flying through Italy and across to Africa. The young follow in late August, finding their solitary way by instinct only.



meadow pipit's nest and becomes permanently imprinted to pipits. It is thought, however, that male cuckoos do not become

mprinted.

Room for one only The cuckoo's egg is incubated with the host's eggs and hatches about the same time, or even earlier. The cuckoo chick is immediately faced with an acute problem of survival: to grow into a much larger bird than its foster parents it needs far greater quantities of food than would be given to each of the bona fide young. It must therefore eliminate all competition. So, when it is about eight hours old, the chick is seized by a powerful urge (lasting about four days) to get rid of any eggs or young sharing the nest with it. To do this-though tiny, blind and naked-it crawls beneath the eggs or nestlings one at a time, manoeuvres them into a hollow in its back and, using its legs and featherless wings, climbs up the side of the nest and heaves them out.

The parent birds take no steps to prevent this, nor to retrieve ejected eggs or feed any young that are thrown out. Eventually the cuckoo has the nest to itself and the entire attention of the foster parents. These birds feed the cuckoo as if it were their own, never abandoning it as long as it goes on begging for food and no matter how huge it becomes.

The rapidly growing cuckoo frequently utters a wheezy hunger cry-'chi-chi-chi'-and this persuades not only its foster parents but sometimes other birds (occasionally even a passing cuckoo) to drop food into its gaping mouth. At about four weeks old the young cuckoo reaches independence, and in August

or September it flies off to find its solitary way to Africa for the winter.

Nest parasitism The large output of eggs ensuring that a fair number are likely to survive - is the chief advantage of the cuckoo's remarkable life style. It is difficult to say how nest parasitism evolved. Only some of the world's many cuckoo species have become parasites. Of these, perhaps the most significant is the American yellow-billed cuckoo which does build a nest and rears its own young: the nest is usually only a very flimsy structure and the eggs often fall out of it, so the female frequently usurps the nests of other birds and uses them to bring up her family. Occasionally she leaves her eggs to be incubated in the nests of other birds. The yellow-billed cuckoo may therefore be a species hesitating on the brink of nest parasitism.

It seems likely that nest parasitism may have originated in birds which first got into the habit of appropriating the nests of other species for their own use. The sight of the eggs in the usurped nest might well have stimulated the newcomer to add another to the clutch. Eventually, the laying of eggs in other birds' nests could have become habitual. One mystery not yet fully understood is why the host species have not become more resistant to such victimisation. The survival value of a bird being a nest parasite is also questionable-it seems very risky for a species to entrust all its eggs to foster parents. However, it is a life style that is very successful: the cuckoo is a numerous bird with a breeding range that spreads across Europe and Asia.

Cuckoo (Cuculus canorus); 33cm (13in) from beak to tail; distribution widespread in woodland, heaths, commons, marshes, fields with hedgerows and coastal dunes; a summer visitor.

Below: A young cuckoo develops rapidly; in three weeks it is far larger than its foster parents and has usually outgrown its nest; so it has to perch nearby to be fed. When it begins to fly a little, the fosterers accompany it and continue to stuff its insatiable beak with insects.



WAYSIDES IN BLOOM

In May and June waysides burst into flower and provide a marvellous show of different shapes and colours by day. At dusk some flowers, like the white campion, perfume the air to attract night-flying moths.

You cannot miss the lesser celandine in flower. Its brilliant shining yellow blooms nestle low in damp parts of hedgerows, woods, among meadow grasses and fall in golden cascades over rocks and stones by streams and ponds.

Each flower has between eight and twelve glossy petals, surrounded by three pale green sepals. After pollination by honey bees and other insects the flowers tend to lose their intense colour and towards the end of their life they become white and rather ragged. The leaves, fleshy dark green and hairless, are heart-shaped and borne on long stalks.

Goldilocks buttercup is another member of the buttercup family, but it is smaller and less hairy than the common meadow buttercup and is the only one to grow in woodlands and hedgerows. Its leaves are deeply divided and hairless. The flower may have five petals, but often one or more are missing; sometimes there are none at all. Then the sepals are a pale yellowish colour.

Cow parsley is one of the most common and delicate-looking members of the parsley family, and the first to bloom in spring. Its small white lacy flowers, a favourite of nectar-seeking insects like hoverflies, beetles, day-flying moths and butterflies, have five petals clustered at the tip of each stalk. The rigid, ribbed green stem is often tinged with purple and the fern-like leaves are separated into pairs of much-divided leaflets. Cow parsley is sometimes called wild chervil, and its young

Right: Male and female campion flowers appear on separate plants. This male red campion is fully developed and about to shed pollen from its anthers.

Below: Flowers attract many different local names, but few are as appropriate and appealing as golden stars, the name given in Somerset to lesser celandines.





Below: Cow parsley (Anthriscus sylvestris) flowers April-June in hedgerows, waste places and beside woods. Ht 80cm (30in). Fruits are shown directly below.

leaves add a mild spicy flavour to salads and stews.

The red and white campions, both members of the pink family, provide a glorious splash of colour to our hedgerows, particularly when they are mixed with bluebells and buttercups and surrounded by the lush green of young leaves and grasses.

The white campion's strong scent attracts night-flying moths such as the elephant hawk moth, but red campion, scentless, is pollinated by long-tongued bumble bees and hoverflies. The two species often interbreed and produce hybrids. Both have hairy green leaves that grow in pairs on the stem, becoming narrower as they reach the tip.

Herb-Robert can easily be identified as a member of the geranium family by the shape and strong smell of its hairy leaves. They grow in clusters at the end of long stalks and vary in colour from reddish brown, through a light to dark green. Small insects such as some early hover-flies pollinate the flowers. The plant's name is thought to have originated from a Frenchman, Abbe Robert, who founded the Cistercian order in the 11th century. He used the leaves of the herb for healing.

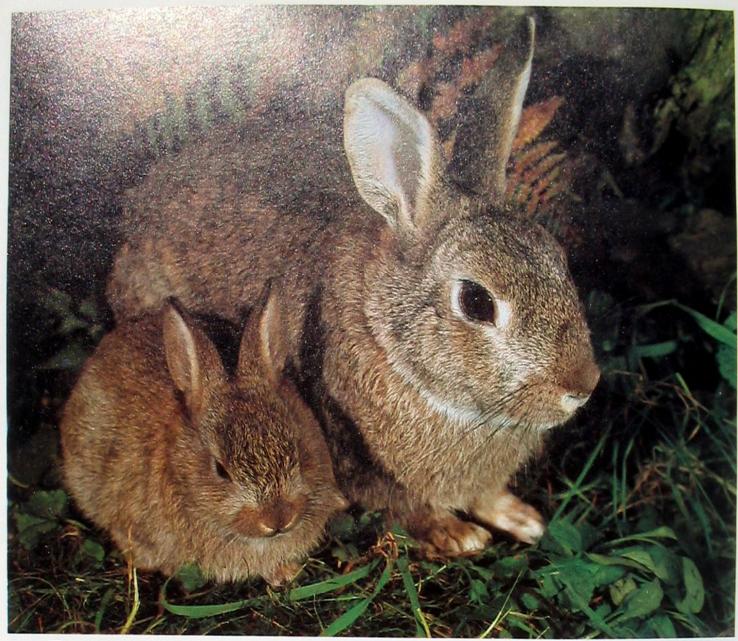
The lesser periwinkle is a shrubby plant with blue-purple, mauve or white flowers that nestle separately in the axils of the leaves. As its name suggests, it is smaller than the greater periwinkle, though just as common.

Right: Herb-Robert (Geranium robertianum) flowers May-Sept in woods and hedgerows, on shingle and among rocks. Ht 50cm (20in).



Lesser periwinkle (Vinca minor) flowers March-May in woodland and hedgerows. Ht 50cm (20in).





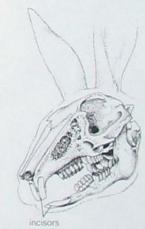
RABBITS: FAST BREEDERS

Threatened by pest control, shotguns and the dreadful toll taken by the virus myxomatosis, rabbits still have an amazing ability to recover and survive in great numbers.

Rabbits were not known in the British Isles before about the 12th century. It is thought they were introduced then from the Continent to provide sport for noblemen and to provide a new source of food and fur. They were originally kept in fenced enclosures, but managed to escape and became the most successful colonizers of all time.

Rabbit spotting You will find rabbits living wherever grass grows, but they particularly favour areas of short grassland such as downland and closely-grazed agricultural land. Their ideal habitat is a small field bounded by hedgebanks, which provide cover and a refuge from predators, and they favour well-drained sandy soil which makes burrowing easy. Normally rabbits prefer to come out of their burrows at twilight and after dark; but if the area is quiet and undisturbed they will appear in broad daylight to feed. The months of May and June are a good time to go looking for rabbits; many you see then are likely to be youngsters. Rabbits do not hibernate in winter so you can still see them in cold weather, although they will be mostly mature adults.

Hopping gait The rabbit's Latin name— Oryctolagus cuniculus—means 'burrowing little hare', but in fact the rabbit and the hare are quite different. The rabbit is generally smaller and moves very differently, making it fairly simple to distinguish even at a distance. It hops along in a series of little leaps, one foreAbove: A doe may produce over 20 kittens each year, in a succession of litters about every 30 days during the breeding season.



Above: Each large incisor at the front of the jaws is chisel-shaped, with a large cutting edge. Behind these are the cheek teeth.



paw slightly ahead of the other, while the hare lopes with long bounding strides. You cannot miss the flashing white underside of the rabbit's tail (scut) when it is running at speed. Its characteristic hopping gait with the bottom bobbing up and down is produced by the powerful, heavily-muscled hind legs which are much longer than the front ones. At high speeds the rabbit's hind legs land ahead of its forepaws. In muddy ground, snow or sand this leaves an easily recognisable track—two large prints side by side in the front (made by the hind legs) and a small round print behind (made by the two forepaws closer together).

Furry animal Rabbit fur is soft, thick, dense and very variable in colour. You may see individuals with fur of any shade ranging between greyish-brown and sandy-yellow; the nape of the neck is usually reddish while the flanks are buff and the underparts white or grey. The distinctive tail, white on the underside, is brown or black on top. Young rabbits sometimes have a white star on their forehead, but you hardly ever see this in adults. A few black (melanic) and some albino rabbits do exist, the black being more common than the white. All rabbits moult their fur once a year, usually in the period between late July and September-the 'neutral' season when neither mating nor breeding is taking place.

Sensing predators The rabbit has superb equipment for detecting potential danger. Its long sensitive ears can be turned in a variety of directions to catch the faintest sound, while its large bulbous eyes are spaced wide apart and angled on the sides of the head so it can see in an arc of over 180 degrees. In addition the rabbit has an acute sense of smell assisted by two sensitive pads situated around the nostrils; these pads are covered by flaps of skin which can be retracted to increase sensitivity. You will often see a rabbit sitting upright on its hind legs turning its head this way and that to catch scent, sight or sound of friend or foe.

Although its furry, soft shape and habit of running away when disturbed may lead you to think the rabbit is timid, it can fight ferociously when necessary and inflict serious injuries with its powerful kicking hind legs and sharp claws. Also the first pair of incisors Above: The courtship rituals are elaborate; here the doe accepts the advances of the buck. The young are born in the nest (right); these are 6 days old.



(there are two pairs in the upper jaw, one small pair behind the big ones) are large and chisel-shaped with a sharp edge and can give a nasty bite.

Social order Although one rabbit may look very much like another, each one is an individual and has to find its own place in the rabbit hierarchy. At the top of the social ladder is the dominant buck who requires all rabbits of lesser status to move out of his way and vacate the best grazing land and burrows. Next in line are the older bucks and does who in turn dominate the weaker or younger rabbits. This system of dominance and subservience is usually called the pecking orderand it exists to a greater or lesser degree throughout the animal kingdom. It is particularly important in animals which live together in large numbers, serving to establish order in a community:

Defending territory All rabbits establish strongly guarded territories which are sharply defined. The buck marks his territory by rubbing his chin along the ground and secreting a strong-smelling, colourless substance from a gland beneath his jaw. An old buck's chin can become bare through constant 'chinning'. The doe also behaves in this way, but to a lesser degree since she is not so concerned with maintaining a territory. The dominant buck guards his territory using display and threat tactics designed to intimidate those of lesser rank. These tactics include squirting urine, scratching the ground with his forepaws, hopping towards other rabbits with a peculiar stiff-legged gait and grazing in short, sharp bites in the direction of the offending underling. If all these threats are ignored, the buck will attack.

Relationships Aggressive encounters are generally bloodless; if, however, threat and RABBIT (Oryctolagus cuniculus) Size of adult rarely exceeds 50cm (19in) and 2kg (4lb); female smaller. Colour coat greyish-brown, underparts white or grey Breeding season one litter every 30 days from November to June Gestation period 28 days. No of young ave 4-6, max 12. Lifespan average 1-2 years, potential max 8-9 years. Food grasses, cereal crops, tree bark. Predators man; fox, stoat,

Predators man; fox, stoat, weasel, badger, ferret; owls, hawks, eagles; wild and domestic cats, dogs.

Distribution grassland especially where hedges, woodland or scrub provide cover. Heaviest in south and south-east England.

Rabbit signs tracks smaller than hares' in print and hopping pattern (shown below). Droppings can be seen near the warren.



3

Life in the Warren

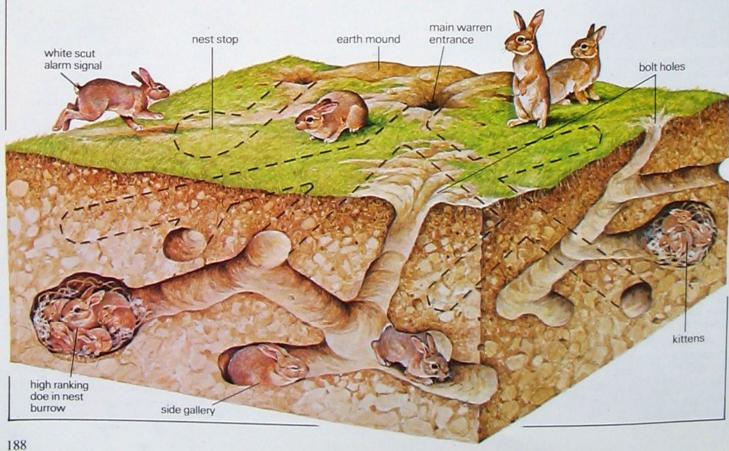


If you see rabbits feeding or hopping across a field, a warren is likely to be fairly near. Rabbits are social creatures and prefer to live together in groups. They dig burrows which form an extensive underground system of inter-connecting tunnels, nests, side galleries and entrance/ exit holes. The entrance holes are usually about 15cm (6in) in diameter and the warren tunnels can reach as deep as 3m (10ft) below ground.

You should be able to spot the main entrance at once by the presence of rabbits (above), or by signs of extensive excavations, a mound of soil outside the hole and an area of sparse vegetation which has been worn down by constant passage.

Tufts of rabbit fur on snags in fences and hedges also indicate a warren nearby. Other signs are droppings and tracks. Warrens are situated where tree roots, tall plants such as ragwort and nettles, banks and hedgerows provide cover against predators.

Tunnel systems are constantly enlarged and the warren can undermine a whole system of fields. As rabbits often feed close to their burrows, they also produce a zone of sparse vegetation which may cause serious soil erosion.



display fail to resolve a territorial conflict, serious conflict may ensue. Vicious battles involving much kicking, biting, tearing of fur and screaming have been known to occur between rival bucks.

In courtship rabbits can display a more gentle nature. Sometimes buck and doe will sit side by side, or facing, and lick each other's forehead, ears and neck in a calm, relaxed manner; or they will play together at night, chasing each other in small circles in a kind of nuptial dance. Mating probably occurs mainly in the burrows at night, when less disturbance is likely from predators or other rabbits.

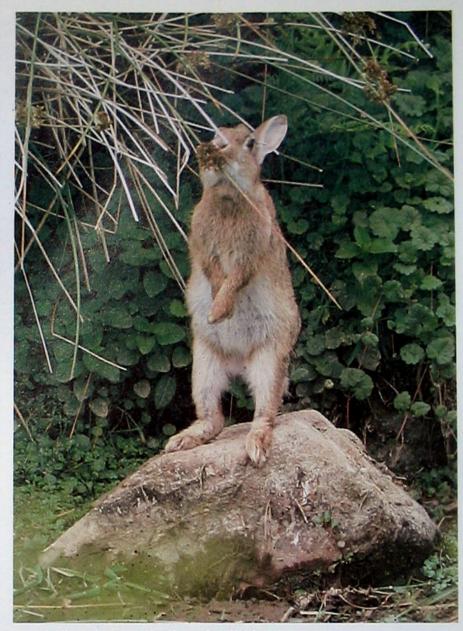
Home security In spring the pregnant doe starts digging her first burrow and sets up the home she and her young will need. The doe digs in very much the same way as a dog; she uses her forepaws to excavate and throws back most of the soil with her hind legs. The buck will assist with the digging but rarely spends more than a few minutes at it. Apart from feeding he is occupied with defending nest and territory, and guarding the doe against other males.

Two types of burrow are prepared. Does of higher rank build their nests deep within the warren, inside one of the subterranean galleries. The younger, weaker does have to make a special burrow—known as a nesting stop—away from the main warren. The doe lines her burrow with scraps of straw, leaves and moss and also pulls fur from a pad on her chest to make the lining even softer. She replaces excavated soil very carefully to make the nest entrance inconspicuous and to deceive possible predators. A chimney-like aperture is retained, leading to the surface so air can circulate freely and allow the kittens, when they are born, to breathe.

Weaning young The new kittens, always born at night, are helpless creatures—blind deaf and hairless and weighing a little over 50g (1½oz). The doe opens the nest for a short period at night to suckle her young and seals it up again when she leaves. Within seven days the weight of the kittens doubles, their fur grows and their teeth and claws become visible. They are suckled for up to a month. Since the doe can be pregnant again even only 12 hours after giving birth (and is nearly always so by two days after), she must suckle and wean her young as quickly as possible.

Population control A doe will produce young only if the environmental conditions are favourable. She will conceive, but in times of food shortage or really great overcrowding (or if there is a continual round of skirmishes and squabbles in the colony), she will re-absorb the embryos completely. This extraordinary form of birth control is more prevalent among younger, weaker does.

Despite all precautions taken by the doe, foxes and badgers often find their way inside the burrows, scraping the soil away from above or uncovering the main entrance. Bur-



rows built at a greater depth are less likely to be invaded by these larger predators, but are vulnerable to weasels and stoats who are small enough to get right inside the warren. In lowland areas, flooding can be another hazard and the young of dominant does living in deep warrens suffer most. It seems in these regions a balance is set up between the two types of burrow. If the weather is exceptionally wet, the young in the shallow nesting stops are more likely to survive; if there are many predators the young in deep burrows will probably fare better.

When a colony becomes overpopulated, the young rabbits in their first year must move out if they are to survive. They stray sometimes far and wide during the autumn and early winter and may fall victim to predators. If they survive, however, they will set up more breeding communities to threaten farmers and their crops.

A later article deals with what rabbits eat, how they eat, the effect on agriculture, and further study of their social behaviour. Above: This rabbit makes convenient use of a large stone for extra reach in getting food.

Killer virus

The virus myxomatosis arrived in England in 1953 via the bloodsucking rabbit flea attached to migratory birds, which had fed on the carcase of a diseased rabbit, or was secretly imported by farmers as a pest control. Symptoms are swellings of jelly-like material on the base of the ears, forehead, nose, anal and genital regions. The eyelids become thick and stick together. The inflamed areas finally exude a watery fluid and the rabbit dies-usually within 11 to 18 days. Rabbits may be growing immune, or the virus weakening, but it will probably never die out.

RESOURCEFUL STICKLEBACKS

During the breeding season from March to June, sticklebacks reveal what a male-dominated species they are. In both the three-, nine- and fifteen-spined sticklebacks the male stakes out his territory, builds the nest and looks after the young.

Single-parent family

Among all sticklebacks the males provide shelter and protection for the several broods each one fathers.

The small three-spined stickleback is one of the most common and widely distributed fish in Britain. Few young anglers equipped with jam-jar and dip-net can have failed to catch one since this species lives in virtually all rivers, streams, lakes and ponds, lurking in submerged bankside vegetation within arm's reach. Moreover, as it is easy to catch and can survive in captivity (so long as it is living in an adequately prepared aquarium), it also appeals to naturalists studying animal behaviour. Possibly more has been written about the stickleback than any other fish.

There are eight recognised species (found only in the northern hemisphere), three of which live in British waters. The fifteen-spined stickleback is a sea fish. The ninespined stickleback is a freshwater inhabitant. The three-spined stickleback seems as content to live in the North Sea as it is to live in a pond on the village green.

Co-existence The three-spined and ninespined species manage to avoid competing with one another in most aspects of their life cycle, although they share the same habitat. The three-spined stickleback favours open water and is most common in rivers and pools, where clumps of water plants or algae provide cover for the fish to hover around and to retreat to if threatened. It will also take shelter among clumps of underwater plants to avoid the strong flow in a river produced by floods, because it is not capable of strong, sustained swimming.

The nine-spined stickleback, like its relative, is not a strong swimmer. But because it seeks out places where submerged plants are dense and lives among the mat of stems and roots at the edges of the water, it has little need to be. It is rarely caught in open water; and when seen there it makes a quick dash for cover.

So although they may live within a matter of metres of one another, the two species probably rarely come into contact. In the River Roding, for example, a small Essex tributary of the Thames, the three-spined stickleback can be caught in the river in pools where the current is slow. The nine-spined species, however, inhabits a small overgrown ditch which feeds into the river through a patch of swampy reed-mace. Push a net into the ditch, and you will bring up a mass of partly decomposed leaves and black mud with only nine-spined sticklebacks in it.

Such places are prone to dry up in hot weather and the water will contain little dissolved oxygen. So it appears the nine-spined stickleback will survive in water at higher temperatures and at lower levels of dissolved oxygen than its relative—as laboratory experiments have also concluded.

Nest building There are also differences in the stickleback's breeding habits. Each species lays its eggs in a nest built by the male in a territory which he stakes out and guards. The three-spined stickleback is unique, however, in choosing to build its nest-constructed mostly of plant fibres and forming a mass of about 5-6cm (about 2in) diameter—in open ground on the bottom. The nest is usually in a hollow on a patch of sand, or gravel and sand, but on mud if the bottom is muddy.

The nine-spined stickleback constructs its

In March the three-spined stickleback claims a territory in shallow open water, defending it against other males until the end of June. He excavates a pit, sucking in sand and spitting it out away from the nest site. Fragments of vegetation are brought to the hollow and 'glued' together with a secretion from the fish's kidneys. This glue is released when the male presses his abdomen against the fragments. Once a nest mound has been gathered he butts it into shape and forces his way through to make a tunnel.

Next, he entices a ripe female to the nest by

nest pit

Next, he entices a ripe female to the nest by means of a zig-zag dance, holding his mouth open and spines erect. He quivers against her flanks, inducing her to spawn in the tunnel, then immediately fertilises the eggs. After this he drives her away.

Male spawns with several females until 300-1000 eggs have been laid.



rather smaller nest among the branches and leaves of water plants some 10-15cm (about 4-5in) above the bottom of the lake or stream. Very rarely the male builds a nest close to the bottom. When this happens he excavates a shallow 'doorstep' at the front of the nest to keep the entrance clear of the mud.

The fifteen-spined stickleback builds its nest among algae in a sheltered pool, or below the low-tide mark, but still clear of the bottom. The nest is roughly ball-shaped, about the size of an orange.

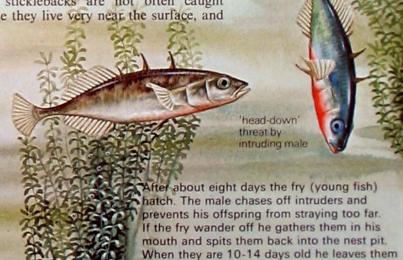
Sea-going three-spined sticklebacks show a similar breeding behaviour to those that live in fresh water. They spawn in a shallow pool, usually well clear of strong wave motion, either in an estuary or coastal pool at about high spring-tide level. Their nests are also found on the open bottom, but built of threads of fine *Enteromorpha* algae or detached fronds of seaweed.

The male fish guards the nest alone; eventually he is joined by the young once they are large enough to swim strongly. They form fairly compact schools swimming in the open

water of pools. These pools are flooded by the high tides of autumn and the fish are swept out to sea. Although the fifteen-spined young also form a loose school for the first weeks of their life, they quickly disperse and remain more or less solitary.

Sea-dwelling The sea-going three-spined sticklebacks only occur in the upper regions of the North Sea. They are very abundant—even in mid-ocean. This was shown some years ago when a fine specimen was caught by the crew of an Atlantic weather ship, in a position almost equidistant between Ireland, Iceland, Greenland and Newfoundland. These sticklebacks are not often caught because they live very near the surface, and

Above: Three-spined sticklebacks are most often seen in shallow water keeping station just off the bottom. Here frys and adults alike feed on small aquatic insects and crustaceans.



to fend for themselves. This pattern is repeated several times during breeding. The nine- and fifteen-spined stickleback story

is similar, but differs in detail. The nine-spined

seaweed. Both freshwater fish perform zig-zag courtship dances but the sea fish adopts a tail-biting ritual. In all cases it is the male which is responsible for the care of the young; the female merely lays the eggs.

fish builds his nest in freshwater weeds and the fifteen-spined constructs his nest in

The male cares for the developing eggs by fanning water around them, so providing oxygen. His vivid colours gradually fade during his parental role.

As eggs develop the male will pull holes in the nest to increase water circulation.

only special nets will drag the upper few centimetres of the water.

The fifteen-spined stickleback, on the other hand, is entirely a coastal species. It is found from the Bay of Biscay to northern Norway, and in the Baltic Sea. It is equally at home in estuaries as in salty seawater, but not in water deeper than 10m (33ft). It characteristically inhabits the eelgrass (Zostera) beds, and sheltered areas where fucoid algae grow. Occasionally it is found in rock pools between the tides.

Spiny protection The three-spined stickle-back is by far the most pugnacious of the three species. The fact that it is the only one living and breeding substantially in the open is a reflection of this. Its several long sharp spines, which lock into an upright position on its back and belly, suggest a degree of protection against predators, and certainly the stickleback comes last in the 'popular prey' list.

There are sticklebacks in the Hebrides which, by some genetic fluke, have no spines at all (or, at most, minute ones). Study of their habitat has revealed that there were almost no animals likely to eat sticklebacks. From this it was inferred that they had survived only because there were no predators in the same locality.

Nevertheless large pike and trout eat threespined sticklebacks, as do otters, kingfishers and a number of sea birds. The other sticklebacks, which adopt a more secretive life style, are not known to fall victim to larger creatures, but this may be because insufficient study has been made of their biology in comparison with the three-spined stickleback.

There are still many questions to be answered about the species, perhaps the most absorbing being what the nearest relatives of the stickleback family can be. For many

Identifying the three species

The names given to the three species provide a clue to their identification, although it is rarely necessary to count the spines to discover which is which. The threespined stickleback is deeperhodied than the other two, but still slender. (The pelvic fins also have a long sharp spine each side.) The ninespined has a rather thin body, but nothing of the eellike slenderness of the fifteen-spined. As its name suggests it usually has nine spines along the back, although this can vary between eight and ten. They are short, closely spaced, and each has a small triangular fin membrane behind it. The dorsal and anal fins are similar in shape and longbased. The fifteen-spined stickleback is long-bodied with an elongated, pointed snout, and a very slender tail. Both dorsal and anal fins have a dusky patch on the



Three-spined stickleback (Gasterosteus aculeatus): up to 5cm (2in), but up to 10cm (4in) at sea. First two spines long and quite stout; third is small.



Nine-spined stickleback (*Pungitius* pungitius): up to 7cm (2¾in). Tail is long and narrow, with fan-like fin. Head small but eyes relatively large.



Fifteen-spined stickleback (Spinachia spinachia): about 15cm (6in). Tail fin is broad and rounded; dorsal and anal fins are short-based and rounded.

years it was thought that they were related to the scorpion fish, so common in tropical seas, and the gurnards and bullheads which are found round Britain. Later studies pinpointed pipefish and sea horses as the nearest relatives. There is not much similarity between sea horses and sticklebacks, but they have relatives which resemble each other. Below: The male threespined stickleback in his full breeding colours is an impressive sight. Not only does he defend his territory during the breeding season, but he also shows sophisticated nest-building skills.





GRIPPING CLIMBERS

Twisting round and round ever upwards towards the light and choking their supports as they go, honeysuckle, traveller's joy and hops nevertheless adorn hedgerows with their beautiful flowers and fruits.

In the British Isles we have three particularly attractive climbing plants: honeysuckle, traveller's joy and hops. They usually grow among trees and bushes, and as they only have weak stems they rely on other plants for their support.

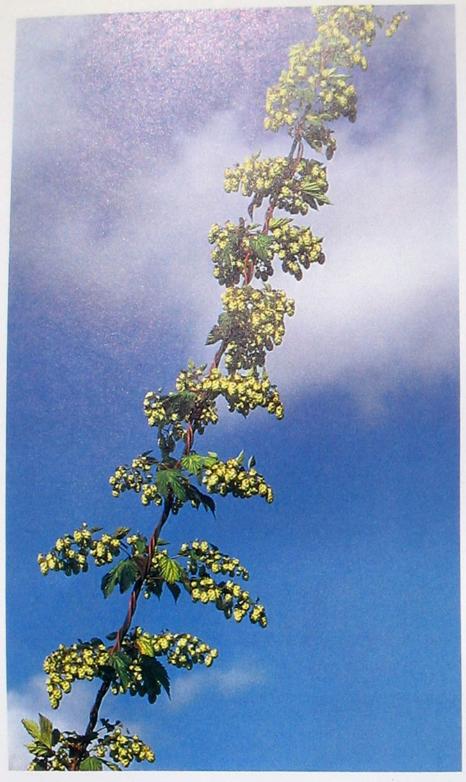
Honeysuckle is a beautiful shrub but a potential killer of trees. Its seedling's stem twines in a clockwise direction round any nearby woody stem. As it worms its way through the trees and climbs across bushes, its tight grip constricts the outer tissue of the

supporting plant. If the honeysuckle latches on to a young tree, it will stunt its growth and distort the shape so that the stem resembles a corkscrew; and if it is allowed to grow unchecked it may kill the tree. For this reason honeysuckle is regarded as a pest where trees are growing commercially, and foresters cut it out. But along waysides it is more of a decoration than a nuisance.

If honeysuckle cannot find anything to cling to, it creeps over the ground, putting down roots as it progresses. Because it requires a good deal of light to produce flowers, it is easy to overlook the plant in deep woodland and thick hedgerows. As soon as it reaches a gap in the undergrowth, however, it bursts into bloom.

Honeysuckle flowers have a heavy sweet scent that is especially strong towards the evening when the deep pink buds first open. Hawk moths, attracted by the perfume, are the main pollinators. They transfer pollen from the outstretched stamens of one flower to the protruding stigmas of another flower, while they probe deeply for the sweet nectar. Other insects, such as bees and flies, land on honeysuckle; but only those with long tongues can reach the nectar. As the flowers

Night-flying hawk moths are the most frequent visitors to the honeysuckle (Lonicera periclymenum). As dusk falls, the flower's exceptionally sweet scent becomes stronger. Once the flowers are pollinated their pinkish-yellow colour deepens.



Above: Charles Darwin, the world famous naturalist, made a study of climbing plants. He discovered that a hop (*Humulus lupulus*) growing at high speed took 2 hours 8 minutes to make one revolution.

Right: Female hop cones. Unfertilised cones have a weaker flavour than the fertilised ones, and are used in some milder types of beer.



mature, they change colour from white to pinkish-yellow.

The round, bright red berries appear in autumn. They are poisonous to humans, but birds and animals eat the fleshy parts and discard the hard seeds on their travels, and this is one of the ways the plant is spread around the countryside.

Man has long made use of honeysuckle. The berries used to be crushed and applied to bee stings. A highly-prized find was a blackthorn stem shaped like a corkscrew distorted by honeysuckle, because it made an attractive walking stick. The shoots were sometimes woven into baskets and they can make a handy piece of twine if nothing more suitable is available.

Traveller's joy belongs to the buttercup family. It is said to have been given its name by Gerard, the 16th century naturalist, to commemorate its presence along every track and byway. Gerard's travels must have been rather limited, however, because the plant is only common south of a line from the Humber to the Mersey. You occasionally see it elsewhere, and it has been introduced into a number of areas including Ireland.

Even in southern England traveller's joy is restricted mainly to calcareous areas and is one of the best indicators of English soils that contain chalk or limestone. On a long rail or road journey it is interesting to see how accurately its presence or absence marks changes in the geology. The rope-like stems festoon hedgerows and sprawl over trees on the edges of woods only where chalk or limestone from the underlying rocks influence the soil.

Elsewhere in Europe traveller's joy grows on a wide variety of soils. But where it reaches the northern limit of its range in England it only survives in soils to which it is particularly well adapted. (The different varieties of clematis that are common in gardens all belong to the same family and are hybrids.)

The greenish-white flowers which have a faint sweet smell grow in profusion at the tips of the stems. They do not secrete nectar, but are visited by flies and bees for their pollen. The tip of the female part of the flower, the stigma, is feathery, and this is the part that enlarges after fertilisation to form a plume which gives the fruits their hairy appearance.

The seeds germinate in the following April or May. The two-leaved seedling develops into a tender shoot with deeply lobed pale green leaves on a long stalk. The young plant climbs forever upwards, twisting in a clockwise direction round the stems of other plants and attaching itself to anything stronger than its own tender stem. The leaves turn into tendrils, curling round the supports. As the plant matures, the stems become tough and woody and the bark splits in long threads.

Hops are probably less familiar as wild climbers since they are more usually thought

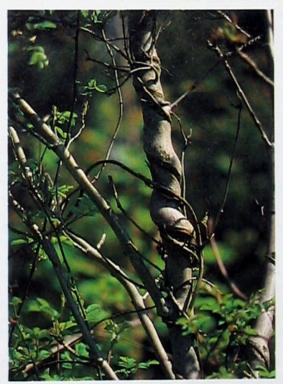


of for the way they twist up 4m (12ft) poles in the hop-growing areas of southern England. The hop is in fact a native plant, although many varieties of cultivated hop have been introduced over the years. The hops that clamber over hedgerows and thickets today are probably a mixture of the original native species and escapes from hop gardens.

Hops start to grow in April. They send out several fragile square stems that twine at great speed in a clockwise direction with the sun, growing as much as 15cm (6in) in a day under ideal conditions. They coil round any nearby shoots, the rough surface of their stems and their deeply lobed leaves making it easier for them not to lose their grip.

Male and female hops grow on separate plants. The male plant produces inconspicuous catkins, but it is the small, greenish heads of the female flowers that develop into the familiar yellow-green cones we know as hops. Each scale of the cone has glands containing lupulin, a mixture of oil and resins. The hops are collected in early autumn and used by brewers to give beer its familiar, slightly bitter flavour. When they are dried they can make quite a comfortable pillow; some people claim that the aroma of lupulin from fresh hops is as good as a sleeping pill.

As climbers, honeysuckle, traveller's joy and hops have the advantage of being able to dispense with the rigid supporting mechanisms required by most trees and shrubs. When



they are young, much energy is used for rapid growth and, in the right conditions, the formation of abundant flowers and seeds. On the other hand, the flourishing growth of traveller's joy and hops depends on their finding appropriate support, although honeysuckle can survive well on its own, adding special charm to the plants it scrambles over.

Above: The silvery fruit cases of traveller's joy (Clematis vitalba), with their hairy seeds, often remain intact until well into the winter. They give the plant its other familiar name, old man's beard.

Left: Although the honeysuckle's habit of twisting itself round trees in an attempt to reach the light makes for some attractive shapes, if it is allowed to continue its growth unchecked it will soon deform and eventually kill its support. Blackthorn stems distorted by honeysuckle can make very distinctive walking sticks.

A SUMMER HEDGEROW TRIO

The hedgerow contains a trio of early summer butterflies—the orange-tip, holly blue and dingy skipper—with all the foodplants, nectar and sunny spots for basking they need.

The brightly-coloured orange-tip and holly blue butterflies are a familiar sight along lanes and hedgerows in most parts of Britain in early summer. The adult holly blue appears in early April while the orange-tip adult is on the wing from late April or the start of May; but they have very different life-styles. A third early summer butterfly, the dingy skipper, cannot match the other two for beauty—it fully lives up to its unprepossessing name—but its life-cycle is particularly fascinating.

Coloured for camouflage Only male orangetips actually have the conspicuous, orangetipped wings; the females have white wings with small black and grey markings. However, when any orange-tip-male or femalesettles with wings closed, you'll be lucky to see it at all. The undersides of the hind wings look like a mottled patchwork of white and green markings. When the butterfly settles among the white flowers and green stalks of hedge parsley (one of its foodplants), it is very well hidden. If you look closely at the green markings you'll see that they are really a mixture of black and yellow scales. This trick - the same used by impressionist painters -makes the orange-tip one of the best camouflaged of all British butterflies; it is necessary because the orange-tip, like most butterflies, is unable to produce green pigments on its wings.

Female orange-tips seek out hedge parsley, cuckooflower and garlic mustard plants which are in flower in May and June when the adults are about. Each female lays only one egg to a plant; she positions the egg on the stalk of a flower that will have turned into a young seed pod by the time the caterpillar hatches just one week later. The caterpillar grows to full size in less than four weeks, feeding on a rich diet of seed pods and seeds rather than leaves. If there were two caterpillars on one plant they would probably run out of seed pods-which is why the female is careful to lay her eggs singly. Orange-tip caterpillars are also cannibals: if another female lays an egg on a plant already occupied, the older caterpillar will eat the younger one.

Early in July the caterpillar leaves its foodplant, which will die down in autumn, and



finds a dry stem on which to spend the winter as a chrysalis. It supports itself from the stem by a girdle that passes round its middle. The camouflaged chrysalis stage lasts for nine to ten months, until the following spring. The entire active life of the butterfly and its caterpillar stage is squeezed into the spring and early summer because only then are the foodplants at the right stage of growth.

The holly and the ivy Like the orange-tip, the holly blue overwinters in chrysalis form. Unlike the orange-tip, however, its foodplants have evergreen leaves so the chrysalis can safely attach itself to the underside of a leaf. The adult butterfly emerges from the chrysalis in April and flits around tall holly bushes but very rarely visits any flowers to drink nectar. When it does need moisture, it usually takes water from the damp soil at the edge of a puddle, or even from the foul smelling liquid on top of a cow pat. You can often see them sitting on paths or rides near a patch of moisture.

In May the female butterfly-distinguished from the male by the broad black borders on her wings-lays her eggs among holly flowers, spacing them out carefully. The caterpillar hatches quickly, eats any smaller caterpillars it finds, and feeds up rapidly on the nutritious flower buds and young fruits (rather than the tough leaves) of the holly. The caterpillar pupates in July. In some years this chrysalis stage lasts right through winter, but more

Above: Male orange-tip (Anthocharis cardamines) on cuckooflower. Look for it in hedgerows in May and June.

Identifying orange-tips



Caterpillar-it is fully grown in about 26 days.



Female-could be mistaken for a cabbage white butterfly.



Male-the only one with orange tips on the wings.



Left: Male and female holly blues (Celastrina argiolus) mating. This is the only blue butterfly to favour trees. Identifying holly blues



Caterpillar-inactive, and occurs in 3 colour forms.



Male-distinguished by the sky-blue upper wing surface.

often the chrysalids hatch as a second, summer generation of adult butterflies. This second generation lays eggs on ivy flowersholly is not available since it is only in flower early in the year. The holly blue is unique among British butterflies in that it alternates between foodplants in this way. The second generation caterpillar feeds up until late August, then pupates and spends the winter months in the form of a chrysalis.

Holly blues are most common in the south of England, and are absent from Scotland. In some years they are very common-probably after a couple of years in which good weather enables both spring and summer generations to breed successfully-and then they may become rare for a few years. It is a species that is often found in towns.



Female-has a noticeable black border on forewings.

The Dingy Skipper



The dingy skipper, in common with others of its family, is more closely related to moths than to other butterflies. It usually rests just like a moth-with wings folded down across the abdomen. The chrysalids are even more moth-like, being protected inside a silk cocoon instead of exposed to view on a twig or stalk. The adults are on the wing in May and June, and fly in typical skipper fashion-a darting, frenzied flight. You'll find them in localised colonies in hedgerows, rough meadows and downland, particularly in chalky areas. The dingy wing colour is good camouflage, so you may have to search carefully.

In May the females lay their eggs singly on bird's foot trefoil-the only food plant of

the caterpillar. The eggs hatch in a couple of weeks and the caterpillar stitches leaves together with silk to make a shelter, living inside well hidden from predators. It eats the leaves and therefore has to rebuild the shelter regularly. Instead of turning into a chrysalis, the dingy skipper caterpillar spins a cocoon and stays inside it-as a caterpillar-from July or August until very early spring. Only then does it turn into a chrysalis, hatching as an adult butterfly in a few weeks. In some areas, particularly in the south-west, there may be a partial second brood-in favourable years appearing in August and September if the early larvae pupate instead of becoming dormant.

The dingy skipper (Erynnis tages) lays its eggs singly on bird's foot trefoil.

egg (life-size)

Egg actual size, on leaf. The larva stitches 3 leaflets together with silk to make a hiding place.

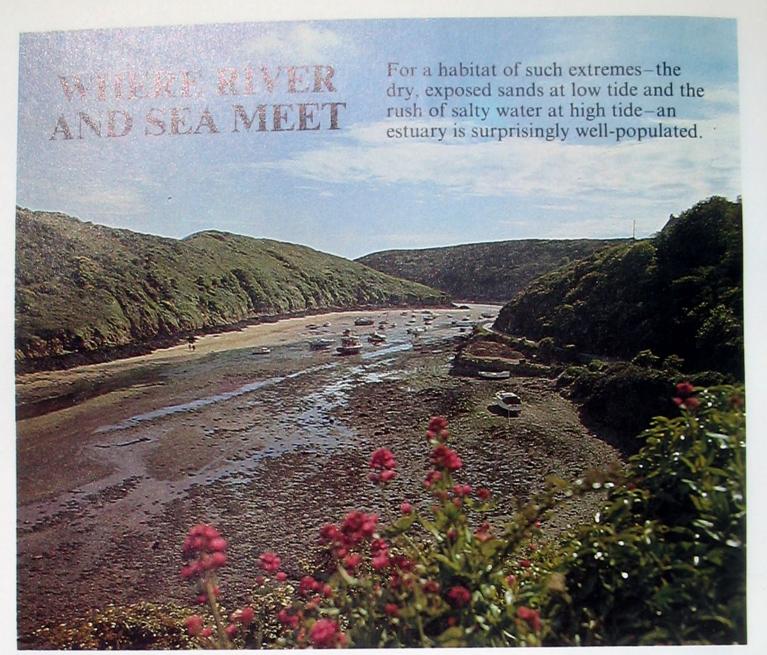
Below: When egg is first laid it is lemon vellow deepening eventually to apricotorange.



Larva, fully grown after 65 days, sews itself up in leaflets and spins a cocoon-a hibernaculum-in which it stays till the following spring.



The pupal stage occurs inside the hibernaculum and lasts 30-36 days after which the adult emerges.



The Solva estuary on the Pembrokeshire coast is bordered by high banks of land as it winds its way out to sea. Only a bare trickle of river is visible at low tide, with a band of wracks lying at the foot of the land on the left, next to a stretch of dry sand. On the right, the tide has exposed an area of gravelly mud, where most of the invertebrates have buried themselves out of reach of the sun's heat.

An estuary is the stretch of water where a river flows into the sea. Some of our largest estuaries, such as the Thames, Humber, Mersey, Solent, Severn, Firth and Forth, provide the sheltered sites of great ports. Other estuaries are in comparison tiny, where a small river or stream enters the sea.

Most estuaries are roughly triangular in shape, with the river water flowing in at the narrow apex and the seawater at the broader base of the triangle. Many of them owe their origin to the 'drowning' of deep, gorge-like river valleys when the sea level rose after the last Ice Age about 10,000 years ago. These drowned river valleys (rias) are common along the coasts of Devon and Cornwall and south-west Ireland. At the same time, the rise in sea-level converted sluggish streams flowing across the lowlands of East Anglia and north-west England, for example, into wide estuaries that extend well inland.

In all estuaries there is a region where sea and river waters meet and move up and down with the tides. In some, notably the Severn, the salt water moves up after low tide in one great block, or 'bore', mixing with the fresh water throughout its depth. But in most estuaries the salt water, being denser and heavier than the fresh, floods in along the bottom of the channels, while the lighter, fresh water forms a layer above it. Of course some mixing of the two kinds of water does occur. One effect of this is to make minute suspended particles of sediment clump together until they are big enough to fall. In this way the tidal mudbanks begin to grow, formed from sediment brought in by the tide from the seabed and downstream by the river.

Changing water levels Within the shelter of an estuary there are virtually no waves. But estuarine water is never still. The level is constantly changing with the tidal inflow of salt water and the outflow of fresh water which increases after rain. Then there is the added complication of the swift currents in the estuary. After heavy rain, these may be so powerful that they scour away the banks, transporting the mud in suspension and later depositing it at the mouth of the estuary. Unlike the seemingly permanent nature of a

wood or pond, the mudbank which is such a prominent feature of the estuary today may be swept away in a storm tomorrow and later reappear in a different form somewhere else.

In the middle and seaward reaches of an estuary, the salinity of the water will range from almost fully salt water at high tide to almost completely fresh water at low tide. The mudflats, vast expanses of mud exposed at low tide, may freeze in the winter's cold or heat up rapidly in the summer sun. Not surprisingly, few species of animals and plants are able to live under such hostile conditions. But those few species that can, thrive and often form huge populations.

Plant life Of the plants, very few species of seaweeds can survive in estuaries, partly because so little light can penetrate through the murky water. One exception is the bright green seaweed *Enteromorpha*, common in rock pools higher up on the open shore. In estuaries it grows over the surface of the mudflats, where its simple thin strands and tubular structures may be anything from a centimetre or two to 60cm (24in) long. *Enteromorpha* is particularly tolerant of fresh water. Brown seaweeds, particularly the wracks, grow in estuaries wherever they can attach themselves to stones, rocks, timbers and other supports.

Of the flowering plants, two of the three British species of eelgrass grow in estuaries, the third preferring the open coast. Unlike the brown seaweeds, eelgrass does not require a firm support to grow on. Instead it thrives in muddy sand, where its deep roots, creeping underground stems, and long, green strapshaped leaves help to stabilise the mudbanks.

Around the margins of a sheltered estuary or tidal gulley branching off from an estuary, you find the salt-marshes. These are large mounds of mud stabilized and covered with plants such as glasswort, cord-grass, seablite, sea manna grass, thrift, sea-lavender and sea aster. These salt-marshes are only completely covered by the sea at high tides. At the top of the estuary, where the water is scarcely salty, large beds of the big reed (*Phragmites australis*) may fringe the banks.

Adaptable creatures Just as the plants which colonise the mud of an estuary are



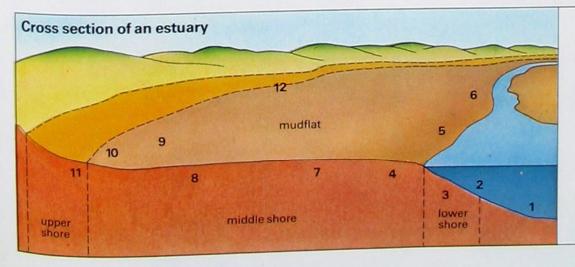
Above: The common shore crab can survive in the upper, almost freshwater reaches of estuaries. When the water becomes less salty it can increase the amount of salt in its own blood. In the background are strands of eelgrass. In the 1930s a disease wiped out eelgrass beds. As a result, the banks on which it had grown were eroded, an industry using dried eelgrass to stuff mattresses collapsed, and large numbers of brent geese, which feed on eelgrass in winter, died,



adapted to living in this hostile environment, so too are the resident animals. The ubiquitous shrimps, worms and shellfish living on or in the mud are able to withstand a wide range of salinities. When conditions at the surface become too difficult, they simply burrow deep down into the mud or sand. Vast numbers of cockles are found in the sand or coarser mud, while it is not unusual for there to be 6000 of the bivalve Baltic tellin living in a square metre of the surface mud.

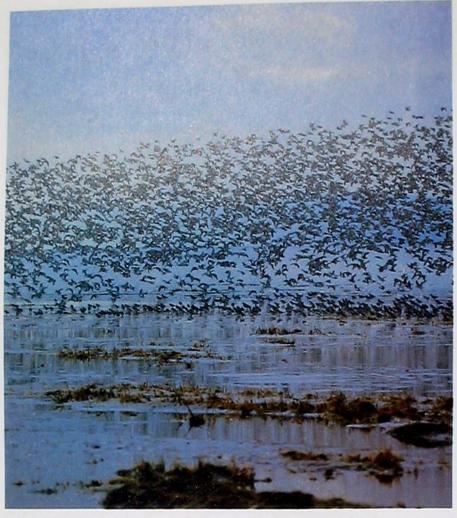
The smallest and most numerous of the estuary molluscs, *Hydrobia*, lives much of its life exposed on the surface of the mud where it feeds on microscopically small algae. Although each *Hydrobia* is only 5 or 6 milli-

Above: Flounders spend much of the day buried in the sand but become active at night, roaming over the shallow water with the incoming tide in search of food. The young flounders feed on small creatures especially crustaceans, while the older ones feed on worms, shrimps and molluscs.



Left: An estuary at low tide showing where you might find some of its inhabitants.

- 1 Common eel
- 2 Flounder
- 3 Ragworm
- 4 Baltic tellin
- 5 Enteromorpha seaweed
- 6 Eelgrass
- 7 Common cockle
- 8 Lugworm
- 9 Bladder wrack
- 10 Shore crab
- 11 Hydrobia mollusc
- 12 Cord-grass



Estuaries are visited in winter by thousands of waders, such as this flock of knots at the Dee estuary in Cheshire. Knots probe the mud and sand for creatures such as periwinkles and hydrobia, and return to the Arctic in spring to breed.

metres long, because of their abundance (populations often exceed 30,000 to the square metre) they seem to be everywhere. In some estuaries, so does the little sandhopper *Corophium*. This crustacean hauls itself out of its burrow and feeds on any organic matter it can find on the wet surface of the mud.

Another common estuary animal is the ragworm. You can find over a thousand of these fierce-looking creatures to a square metre of mud. Growing up to 10cm (4in) long, each inhabits a small mucus-lined burrow from which it emerges to feed when the tide comes in. Another common burrowing worm in the muddy sand is the lugworm.

Fish Not surprisingly, these multitudes of invertebrate animals provide an important food supply for many fish and birds. The typical estuary fish is the flounder. Although these flatfish spawn at sea they can survive in fresh water for a considerable time. Grey mullet swim up the estuary with the tide. Lacking teeth, these fish suck up tiny algae for food. Eels are common in estuaries too, since they stay there for a while during their migrations to and from the Atlantic spawning grounds.

In a hot, dry summer Atlantic salmon, which are also migrants, may wait in the estuary until heavy rain rises the water level sufficiently for them to make their way up the river to spawn. Other estuarine fish include the three-spined stickleback, smelt, sprat, sea

trout and the gobies.

Nesting birds Because of its unstable, tidal nature, few species of birds nest on an estuary. However, black-headed gulls often breed in colonies on the salt-marsh and common terns on the shingle ridges; oystercatchers are also frequently around. From time to time, a pair of mute swans may build a massive nest in the upper reaches of the estuary.

One regular estuarine breeding bird is the shelduck. By early spring this attractive bird has built a nest containing up to a dozen eggs in a disused rabbit burrow or in the vegetation at the edge of the marsh. While one of the pair incubates the eggs, the other keeps watch for enemies from some distance away. In July the shelduck migrates to a special moulting ground, the Heligoland Bight off north-west Germany, returning to its home estuary in late autumn.

Feeding grounds Cormorants and herons fish the estuary waters throughout the year, and a few non-breeding curlews, redshanks or plovers may stay out on the estuary during the summer. But at that time most estuary birds are far away in the Arctic zones of Greenland, Scandinavia and even Siberia.

It is in winter that estuaries come into their own as feeding grounds for swans, ducks, geese and waders from northern Europe and beyond. Each estuary then becomes a magical place, orchestrated with the fluting calls of thousands of birds attracted by the large concentrations of invertebrates and plants. The absence of cover in the open estuary means that a predator cannot approach unobserved, and so the birds can feed safely in huge flocks.

A few species of mammals visit the estuary: rabbits and water voles may graze the marshes, and foxes go to hunt there. The rare otter and the not-so-scarce mink may seek food along the creeks and tidelines, while seals, porpoises, dolphins and killer whales occasionally rest or fish in the estuary waters.

Grim future The wildlife of estuaries is, however, in danger. Teesmouth is being reclaimed for industrial use, the Wash and Morecambe Bay may be used for water storage. Maplin Sands in Norfolk, the Dee, the Solway and even the remote Cromarty Firth are threatened with development. Vast areas of estuarine marshes are being drained and reclaimed for farmland or used as rubbish tips, while there is the constant threat of pollution from farms, factories, oil refineries and power stations. Parts of a number of estuaries have been set aside as nature reserves under the watchful eye of several conservation bodies. But even though a section of an estuary is protected, it can still be affected by pollution many miles away.

The future of our last great wilderness is anything but secure. No one in Britain is more than 50 or 60 miles from an estuary, so make the best use of your local estuary while it is still there.

A FARTHING FOR ITS SONG?

The perky, diminutive wren-the smallest British bird apart from the goldcrest-is ideally suited to its foraging life in the undergrowth of woodland and hedgerow and, with ten million breeding pairs, is our most numerous species.

The wren, with its barred brown and grey plumage—similar in both sexes—is well-camouflaged in the undergrowth it frequents. But you can identify the male by his exceptionally loud 'churring' call.

In legend the familiar brown wren is condemned to live a skulking life of shame for cheating in the great election to find the king of the birds. The story goes that the birds decided to choose as their king the one which could fly the highest. Hoping to win the contest, the cheeky wren concealed himself in the plumage of the mighty eagle and hitched a ride for most of the way, only emerging to outfly the eagle when it finally tired. The strength of this legend, which appears in many countries and cultures, testifies to Man's ancient association with and fondness for the perky little bird.

Tiny troglodyte The wren prefers to frequent holes and corners in cliff overhangs, derelict buildings, outhouses, tree roots and piles of boulders. Its scientific name means 'the cave-dweller'—a name not to be taken too literally, but nevertheless apt since the bird is one of the few able to exploit such recesses and cavities. It is an active little bird, full of verve and familiar in town and country.

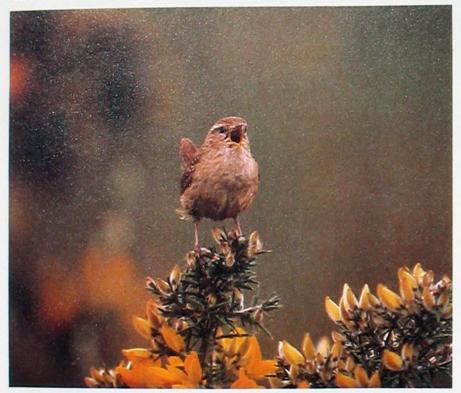
The rounded, dumpy body, short whirring wings and cocked tail may look ungainly, but in fact the wren is superbly equipped for its ground-foraging way of life. It creeps about in the undergrowth in a characteristic crouched posture-very much like a small rodent-negotiating its way efficiently through narrow openings and working energetically through tangled vegetation, tree roots and



brambles. On a branch, its tail-cocked perching position is unmistakable.

Year-long songster The sexes are indistinguishable in plumage, but only the cock sings. For the size of the bird's body, the volume and carrying power of the song is remarkable. The male sings consistently throughout the year and song is important in his life. He uses one type of call—a vehement, rattling warble usually lasting a few secondsfor a variety of purposes: territorial warning and defence, courtship, attracting others to roost and communicating with partners. In the excitement of courtship and nesting, he will even sing with his beak crammed full of building materials!

Wren (Troglodytes troglodytes); 10cm (33in) from beak to tail; distribution widespread; resident.



Above: A male wren singing to proclaim his territory. Apart from a series of loud warbling calls, the wren's repertoire includes cheery trills and a scolding 'tit-tit-tit' sound.



Right: The wren's domed nest, made of moss, dry grass and bracken and lined with feathers, makes a secure, snug home for the young. Some wrens prefer to nest in close proximity to Man and choose odd sites to build—such as in an old cap hung in a shed.

Numerous nests The wren's breeding season starts from the second half of April onwards. It is catholic and often quaint in its choice of nesting sites, frequently ignoring natural recesses in hedge bottom, ivy bank or upturned tree root in favour of man-made places such as outhouses or the corners of gardens.

The cock builds several nests—outsize, domed structures of moss, dry grass, bracken or leaves—to tempt his mate. The hen selects the one of her choice, lines it with feathers, then lays from five to twelve eggs and incubates them by herself for 14 or 15 days. The glossy white eggs are often speckled with minute black or red-brown spots at the large end. When the young hatch, the male leaves the female to do all the feeding. The hen usually rears two broods a season, especially in more vegetated areas where food is plentiful. The male bird—not the most diligent of parents—may install several females in succession in different nests.

Success story The wren is a successful and adaptable bird-something that is particularly noteworthy since it is the only Eurasian representative of an extensive family of otherwise exclusively New World birds. Not only is the wren one of the most widespread of all our birds, it is also extremely numerous. Densities of up to 100 pairs per square kilometre have been recorded. At the same time, the wren is vulnerable in hard winters, when numbers may fall dramatically. However, the rate of recovery can be equally dramatic: after the cold winter of 1962-63, the wren recovered numbers faster than any other common bird.

The wren is almost entirely insectivorous. Its diet is composed mainly of the larvae of small moths, flies, beetles and other insects, as well as spiders, mites and a limited variety of small soft-bodied invertebrates—all probed, extracted or caught with the bird's fine, slender, slightly curved bill. It is little wonder that protracted hard weather—which decimates insects—spells disaster for the wren. Unfortunately, it is our one garden visitor that is not drawn to bird tables, so it is no use putting out extra food in the hope of saving it from starvation. In times of plenty, however, there are probably up to ten million breeding pairs of wrens in existence.

Quite a crowd One oddity of wren behaviour is communal roosting which sometimes occurs in particularly severe weather. Wrens are usually solitary at night, but large numbers are sometimes found roosting in very confined spaces, the birds huddled together in a feathery mass with tails pointing outwards. As many as 30 or 40 individuals have been found in one nest box, in tier on stifling tier. Obviously, the insulation obtained by this crowding has a high survival value in hard weather. It helps the birds retain the precious body heat they have gained from hard-won insect food foraged during the



short winter daytime. After the young have fledged in summer, but before they have become independent, parent birds can sometimes be seen shepherding their families to the safety of a communal roost.

Island races Wrens are not only found in woodland, farmland, river banks and suburban gardens—where we are most familiar with them; they also occur on sea cliffs and mountainsides. They even inhabit some of our furthest—flung islands, particularly Shetland, St Kilda and the Hebrides. On these islands the species has been isolated for 6000 years or more and has produced distinctive, clearly separated local races. The island birds tend to be larger and greyer in colour and have heavier chestnut-coloured barring on the back than their mainland relatives.

The wren hunt The wren frequents the dwellings of Man more than any other bird, and it is not surprising that legends about it abound. One curious and ancient custom—the wren hunt—which originated over 1000 years ago took place (in various forms) in

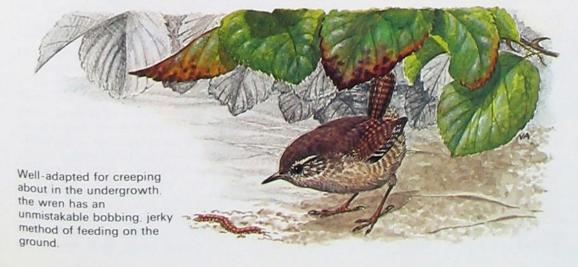
many parts of England, and was particularly popular in Ireland, parts of Wales and the Isle of Man. The hunt was specially associated with St Stephen's Day (26th December). Wrens were hunted along hedgerows, and through woods with sticks, stones, bows and arrows or birch rods; any found were killedoften ritually. They were then borne through the town on an elaborate bier or specially constructed wren house by grotesquely dressed 'wren boys'-all to the accompaniment of traditional wren-hunt songs. In many ceremonies, money was solicited by the wren boys for 'the burying of the wren'. The hunt persisted until very recent times, and in Ireland is still practised. Its origins go far back into history: it is said that a wren hopping on a drum awakened the Danes and foiled a stealthy Irish attack.

Fortunately for the wren, it has outlived the barbarous hunt; now, though we no longer have the farthing coin which carried the wren emblem and testified to its popularity, the bird is fully protected by the law. Above: A parent wren bringing a beakful of insects to its young in the nest. Its short wings make the wren's flight rapid and whirring. Note the characteristic white eye stripe.

Polygamy in birds

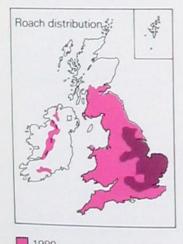
Most birds have only one mate; the advantage is that both parents help to rear young. Some birds, however, practise polygamy—having more than one mate. Male wrens often do this, especially where food is plentiful and the hen can feed the young on her own.

There are two types of polygamy. Simultaneous pairing can take place with two or more females (as with corn buntings). With successive polygamy, the male initiates consecutive broods with different females. Male wrens do both. The advantage is that the largest possible number of broods can be produced without the male increasing the size of his territory; also the female may have the opportunity to select more vigorous, active males-to the benefit of the species.





Above: The roach (Rutilus rutilus) rarely grows longer than 45cm (15in) or weighs more than 1kg (2lb). It has a dark, rounded back, silvery-white sides and reddish eyes.



early Roman times

The map above shows how the distribution of the roach is thought to have increased from Roman times to the present day.

RESILIENT ROACH

The roach survives and flourishes in more varied conditions than probably any other freshwater fish in Britain, so much so that the species has spread dramatically throughout Ireland in just 30 years.

The roach is a member of the carp family, which makes up the major group of British freshwater fish. One of the notable features of this group is that they have no teeth in their jaws. Consequently their food consists mostly of small invertebrates and plants; they are never aggressive fish-eating predators. Yet somehow the roach has come virtually to dominate the rivers and lakes of Britain (but not of Scotland), and is possibly our most common fish.

Invading Ireland Roach are not native to Ireland, and the story of their spread there is symptomatic of their resourceful nature. Imported probably in the 1950s, roach were stocked in a lake in County Tyrone. At that

time the nearby river Foyle flooded and some fish escaped from the lake into the river. By 1957 the roach in the Foyle were attracting the attention of anglers because the fish were both numerous and fine specimens. During the 1960s and 1970s roach spread through the Foyle river system, into the Erne and the Shannon, and are now commonly found in many waters of Ireland.

Survival skills It seems that once it has become established in a river, the roach will spread far and fast. This is just as true in England and Wales. One of its qualities is its adaptability. It inhabits both lakes and rivers, although it is not well-suited to the fastest streams. It can withstand the relatively high water temperatures of ponds in summer, and also in rivers where the water has been used for industrial cooling, which raises the river temperature. The roach is well known for its tolerance of moderately polluted waters.

The roach can also survive on relatively small amounts of dissolved oxygen, which means it is capable of thriving in small ponds and stagnant backwaters where oxygen levels are often low in warm weather. It can adapt equally well to low levels of dissolved oxygen in extremely severe winters, when the water is ice-covered for weeks. These conditions usually kill off other fish.

Abundant food The roach eats a wide range of animals, helping it thrive in unfamiliar waters. The young roach feeds on microscopic aquatic animals such as rotifers, diatoms, small copepod crustaceans (relatives of the water flea) and water fleas themselves. As it grows it eats more insects, including large numbers of mayflies in all their developing stages, caddis and midge larvae, also waterboatmen and water beetle larvae. Roach also eat water snails and freshwater shrimps together with other crustaceans.

The roach eats a certain amount of algae, especially during spring and summer, but some of this may be accidentally swallowed while feeding on animals that live on water plants, or on the river or lake bed. Few fresh waters do not contain such a mixture of animal life, so the roach usually has plenty of suitable food for its wide-ranging diet.

Spawning success Another factor in the roach's success story is that each female produces a very large number of eggs. Assessed as so many thousands of eggs per kilogram of fish, the roach comes high on the scale at around 50,000 eggs per kilogram. This is not as high as the tench, which produces about twice that figure. However, tench may fail to spawn in a cold spring, whereas the roach can spawn at temperatures of 14-15°C (58-60°F), usually from April to May. The roach fry therefore get off to an early start and are ready to take advantage of any boom in the food supply that may occur.

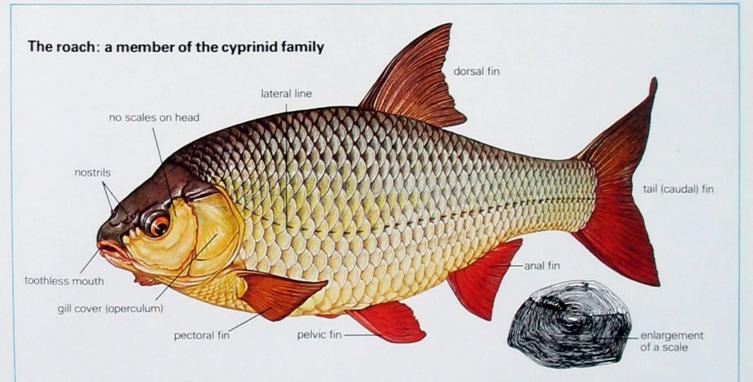
Roach are curiously aggressive when spawning. They frequently mingle with



spawning rudd and bream (their nearest relatives in Britain) and produce hybrids. These are sterile or have only low fertility, and so fail to dominate the waterways. Rudd and bream do not seem to return this intrusion, and the roach are therefore left alone to their own prolific spawning.

Man's influence The most potent of all the influences in the roach's success is undoubtedly Man. By altering so many rivers for navigation, building canals, constructing reservoirs and making gravel pits, Man has provided many new and highly suitable habitats for the fish. As it is also a highly popular angling fish, the roach has been transported to many new areas.

Above: This slow-flowing water leading into the River Avon, near Bickton Mill in Hampshire, is typical roach territory. The roach tolerates poorer quality waters, even those with moderate pollution, and so spreads rapidly—much to the delight of anglers.



Members of the carp family, known as cyprinids, include the carp, tench, chub, gudgeon, bream and minnow, as well as the roach. They form the major fish fauna of British fresh waters. Typical features are fins without a series of spines in them, a single dorsal fin and no teeth in their jaws, compensated for by a set of teeth on paired bones in the back of the throat to help them crush their food. The scales of cyprinids cover the body but not the

head, and have no toothed edge (magnified above); they are called cycloid scales.

Like most other fish the roach swims by side-to-side sweeps of its tail, the caudal fin acting like a sculling oar. Both the dorsal and anal fins keep the body steady, while the pectoral and pelvic fins help the moving fish to stay level in the water—and also to make small correcting movements when the fish is still.



MAY IN BLOOM SAYS SUMMER IS HERE

Of all our native trees, the common hawthorn has contributed most to the patchwork appearance of the British rural landscape. It forms dense thorny hedges and thickets, teeming with wildlife, and its glorious bloom in May proclaims the oncoming summer.

There are two species of hawthorn in the British Isles, the common hawthorn and the Midland hawthorn. The common hawthorn is abundant throughout the country, except in the far north of Scotland. It thrives on most soils, in open habitats such as hillsides, neglected pastures, on commons and in woodland and most hedgerows. Left to itself it grows in dense thickets and forms a distinct habitat during the natural transformation of grassland into woodland. In open, exposed places, especially around the coast, its growth becomes stunted and shaped by the strong prevailing winds.

The Midland hawthorn is not nearly so widespread and is more or less confined to the east Midlands and south-east England, where you often find it in the shrub layer of oak woods. You can distinguish between the two species by looking at the leaves and flowers.

The leaves of the common hawthorn have distinct lobes and indentations that may reach as far as the midrib. The tips of the lobes tend to be serrated, and the whole leaf is longer than it is broad. The leaves of the Midland hawthorn are more rounded in outline, with small lobes and shallow indentations, and are broader than they are long. The leaves of both hawthorns have a nutty flavour; they used to be eaten by children and were often called 'bread and cheese'. The foliage is devoured by huge numbers of insects, especially the caterpillars of various moths such as the winter and the burnished brass. In autumn the leaves turn in colour to rich tints of red, orange and yellow before the wind and frost strip the branches bare.

Blossom Hawthorn blossoms in Mayhence the familiar name, May-shortly after the leaves have unfurled. The trees soon become smothered in clusters of white, and occasionally pale pink, flowers. (Some of the crimson and double-flowered varieties that are common in city streets have been introduced.) Common hawthorn flowers have only one style (female part) and seed which develops later inside the red berry. Midland hawthorn flowers have two or occasionally three styles and seeds. Often the two species hybridise and then both types of flower

Far left: Hawthorn in bloom in May. An old country rhyme recommends the tree as protection for man and beast in thunderstorms:

Beware the oak—
it courts the stroke.

Beware the ash—
it courts the flash.

Creep under the thorn—
it will save you from harm.

Right: The pink anthers of hawthorn shrivel and turn brown after shedding their pollen.





appear on the same tree. The hybrids are faction

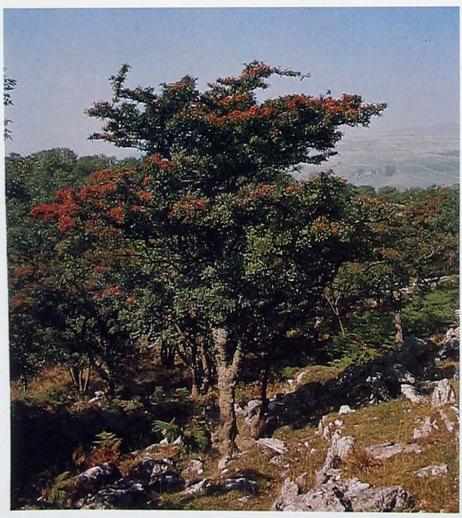
The persist, known as haws, start to turn red in late August and provide a rich splash of colour along wayside hedgerows well into autumn. However it is not unusual to find bunches of berries which appear not to have ripened at all; these remain yellow-green.

Haws last well into winter and are a vital source of food for birds, especially during cold spells. Blackbirds, thrushes and large flocks of redwings and fieldfares—winter visitors from northern Europe—are just a few of the species that can be seen along hedgerows, settling to pluck the berries from their stalks.

Right: A dormouse tucking in to ripe haws. The carbohydrate in the flesh of the berries helps the animal to fatten up for winter hibernation.



Below: Hawthorn bearing typical red berries in autumn in Yorkshire. This species is one of the first colonizers of scrubland and uncultivated areas.



Birds are essential to the spread of hawthorns. The seeds, embodied in the berries' flesh, have a tough coat which prevents the pip being digested by the birds which eventually drop them some distance from the parent tree.

Living fences Common hawthorn has been used for about 2000 years as natural barbed fencing. Its tangle of thorny branches is an ideal barrier for enclosing livestock. Indeed, the Anglo-Saxon word is *haegthorn*, which means hedge-tree. Signs of defensive hawthorn hedges have been found round the edge of excavated Roman forts. Evidently their function was to keep out marauding native warriors bent on driving the occupying army from their homeland.

During the last 300 years hundreds of miles of hawthorn hedge were planted as an alternative to stone walls, ditches or hurdles. In this century they have increasingly been grubbed out or replaced by fencing that requires less maintenance.

Trees Unmolested by hedge-cutters, hawthorns grow into medium-sized trees with dense, rounded crowns. They live for a surprisingly long time: their natural span is usually around 100 years but specimens that have reached the ripe old age of 300 are not uncommon. In old age the trunks become gnarled, twisted and furrowed. Constant rubbing by cattle tends to polish the bark leaving it with rather a glossy sheen. The trees' slow growth produces very hard wood. Hawthorn logs burn well, but curiously this tough timber is otherwise little used, except occasionally for tool-handles and walking sticks.

May Day During the celebrations of the arrival of summer, maypoles were erected on village greens and in town squares and decorated with garlands of May blossom. However it is traditionally thought to be unlucky to bring sprigs of flowering hawthorn indoors. Superstition holds that it may result in a death in the family.

Quite recently it was discovered that one of the chemicals that make up the flowers' sweet scent is also produced during the decay of corpses. Small wonder, then, that people were reluctant to bring the 'smell of death' into their homes. It seems likely that the superstition dates back to outbreaks of the Great Plague when so many dead lay unburied.

Legendary thorn The most famous hawthorn in England is the Glastonbury thorn.
One legend surrounding this unusual tree
goes back to the time when that part of
Somerset called Avalon was surrounded by
sea. Joseph of Arimathea was supposed to
have landed there during his pilgrimage from
the Holy Lands of Palestine. Resting after
climbing a particularly steep hill, Joseph
thrust his thorn staff into the ground where it
miraculously took root and flowered immediately.



IS IT A RUSH, A SEDGE OR A GRASS?

It is quite easy to dismiss sedges, rushes and grasses as apparently rather dull look-alikes. Careful inspection in damp areas such as bogs, fens, rivers, ponds and marshes reveals a number of individual species, each with clearly distinguishable characteristics.

Common reed—the tallest member of the grass family in the British Isles—growing at Slapton Ley in Devon. If a young reed stem is broken, it exudes a sap which hardens into a sweet gum the North American Indians used to eat as sweets.

On land which is flooded or boggy for the greater part of the year, plants with narrow leaves and inconspicuous flowers make up the bulk of the vegetation: these are the rushes, sedges and grasses. Being wind-pollinated, they lack the attractive colours and scents of insect-pollinated flowers.

Rushes The flowers of rushes are green or brown. The inflorescence, the part of the plant bearing the flowers, is either at the tip of the stem or a few inches below it; on close inspection, each individual flower can be seen to have six papery petals.

Some rushes have flat, grass-like leaves with distinctive straggling hairs along either edge: these are the wood rushes, common throughout the British Isles. More familiar, though, are the rushes which grow in huge tussocks in wet ground. With some species, such as the soft rush, the stem can be split open to reveal a soft pith, rather like foam rubber. This was once used for the wicks in candles and rush-lights. The tough leaves are still used for chair and basket-making.

Sedges Although sedges and rushes appear superficially similar to one another they are in fact quite easy to distinguish. A rush stem is cylindrical and contains spongy pith. A sedge stem is often three-sided and usually solid, and the leaves grow in three rows up the stem.

A particularly striking wetland sedge is cottongrass which bears a head of fluffy white hairs. All British sedges belong to the Cyperaceae family and most to the genus Carex. Often all the male flowers are at the tip of the stem. Lower down the stem the female flowers become swollen with seeds.

There are about 80 different types of sedge in the British Isles. Two of the most distinctive species are the carnation sedge which is conspicuous for its bluish leaves, and the greater tussock-sedge which grows in huge clumps. Great fen sedge is easy to recognise for its big grey-green leaves armed with vicious teeth along the edges.

Whereas rushes and sedges are often (though by no means always) found in wet places, the true grasses have colonised a wide

1: Reed sweet-grass (Glyceria maxima) flowers July-Aug in deep water of rivers, ponds, canals. Ht 2m (61ft). 2: Common reed (Phragmites communis) flowers Aug-Sept in shallow water and swamps. Ht 3m (10ft). 3: Blunt-flowered rush (Juncus subnodulosus) flowers July-Sept in fens. marshes. Ht 120cm (47in). 4: Bulbous rush (Juncus bulbosus) flowers June-Sept in bogs, moist heathland, damp woods, usually on acid soils. Ht 10cm (4in). 5: Soft rush (Juncus effusus) flowers June-Aug in damp woods, bogs, wet pastures, particularly on acid soils. Ht 150cm (60in). 6: Common club-rush (Scirpus lacustris) flowers June-July in wet. silty areas, rare in Wales. Ht 3m (10ft). 7: Black bog-rush (Schoenus nigricans) flowers May-June in damp places and by the sea. Ht 75cm (30in). 8: Common cottongrass (Eriophorum angustifolium) flowers May-June in bogs and fens. Ht 60cm (24in). 9: Common sedge (Carex nigra) flowers May-July in damp, grassy places and beside ponds and streams on acid or basic soils. Ht 70cm (27in). 10: Lesser pond-sedge (Carex acutiformis) flowers June-July in damp woods and beside streams, usually on heavy clay soil. Ht 150cm (60in). 11: Greater tussocksedge (Carex paniculata) flowers May-June in wet places out of direct sunlight. Ht 150cm (60in). 12: Carnation-sedge (Carex panicea) flowers May-June in fens and wet grassy places. Ht 40cm (16in) 13: Great fen-sedge (Cladium mariscus) flowers July-Aug in reedswamps, fens. Ht 3m (10ft). 14: White beak-sedge (Rhynchospora alba) flowers July-Aug in wet,

range of habitats throughout the world, from hot deserts to cold polar regions.

Grasses have hollow cylindrical stems; the flowers do not have petals, but are enclosed in two scale-like lobes called glumes. Our tallest native grass, the common reed, is a useful wetland plant: its stems and leaves provide thatching materials and its creeping stems bind river banks together and help to prevent soil erosion. However, if it is not managed properly it can block up whole river systems.

To identify the common reed pull one of the leaves away from the main stem. At the point where the blade meets the sheath clasping the stem you will see a collar of hairs or ligule. In many other grasses this ligule is membranous rather than a crown of hairs.

In most wet places the sweet-grasses put in an appearance too. They range from the diminutive glaucous sweet-grass to the reed sweet-grass which rivals the common reed in stature. The tip of a sweet-grass leaf is shaped like the bows of a boat, in contrast with the flat tips of reed and canary-grass leaves. Sweet-grasses are luscious plants, eagerly grazed by cattle. Because they are nutritious they are encouraged by farmers.



acid soils. Ht 50cm (20in).







Soft rush growing at the foot of Cwm Idwal in Snowdonia, Wales. The pith was once used for the wicks in candles and rush-lights.



Greater tussock-sedge seen here with marsh marigolds. Given the right peaty soil, it grows in clumps as much as 1m (3ft) wide.

GRACEFUL GRAZERS OF THE WOODLAND

By the early summer the male fallow deer is growing a new set of impressive and distinctive antlers in readiness for the autumn rutting season. After this mating period, the female deer gives birth to a single fawn in the following June.

Fallow are the most widely dispersed deer in the British Isles, including Ireland—where roe deer are absent. Their natural habitat is deciduous or mixed woodland with thick undergrowth.

Fallow deer existed in the British Isles more than a million years ago, but died out during the Ice Age. The Normans reintroduced them to Ireland in 1244, and almost certainly to England before that date. Since then fallow deer have been widely kept in special deer parks—of which there are currently just over 100—partly for their attractive appearance

and also for their venison. You have a good chance of seeing these deer at close quarters in many town parks, such as Richmond Park in London, as well as zoos; in both locations they have learned to tolerate humans.

Wild herds that are found in areas such as Epping Forest, The Forest of Dean, Cannock Chase and the New Forest are descendants of those deer reintroduced by the Normans; but many wild herds have a closer ancestry to park deer which escaped during the two World Wars. Deer parks were neglected and fences fell into disrepair at these periods, and this enabled large numbers of deer to escape. Left alone in the wild, these herds flourished and multiplied.

Signs and tracks In the wild, fallow deer are shy and elusive creatures. Unless you move very quietly, they will take fright and you will catch only a fleeting glimpse of them as they run away. So it is best to look for signs which give away their presence in a wood; these are provided by the outline of the trees.

Fallow deer feed on leaves and twigs. The branches of the trees are cropped off in a



straight line about two metres above the ground-the highest the deer can reachgiving them a nar-bottomed shape. In muddy ground you may see cloven hoofmarks; these are, however, similar to those of sika, roe and red deer and even sheep, so you will find it difficult to tell them apart.

The droppings of these deer species are also alike, with some variations in size between the species and the sexes. Fallows' are glossy, black, striped cylindrical pellets, pointed at one end. The pellets of an adult male (buck) are about 12mm (1/2 in) square; those of the

female (doe) are slightly smaller.

Coat colour Although fallow deer vary considerably in colour, you will most likely see the dark-dappled 'Bambi' coat. This summer coat is a rich, glossy brown with white spots. Before winter it changes to grey-brown with barely discernible spots. The white rump patch is edged by a black horseshoe-shaped line. The tail, which is about 18cm (7in) long, is white below and black on top-a continuation of the black stripe that runs down the mid-line of the back. The deer shows its white scut with a flip of the tail to warn other members of the herd of any danger.

There is a paler variety, with black markings replaced by brown and the main body colour a lighter fawn. In winter the spots remain distinct. The so-called black variety has a glossy jet-black coat in summer, with elephant-grey belly and legs; the spots are indistinct and dappled. The coat becomes

duller in winter.

The other main variety you are likely to see is white or pale ginger; these deer are partial albinos and have orange hooves and a pale nose. They are sandy coloured at birth, becoming gradually whiter during their first few months. You will see many intermediate shades, since deer of different colour varieties can interbreed, and the offspring are not necessarily the colour of either parent.

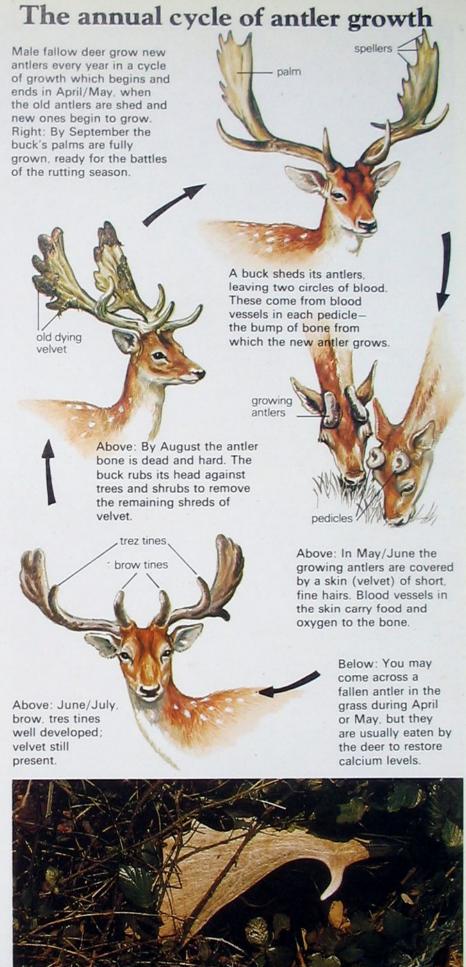
Elegant heads Both the buck and doe fallow deer have a gracefully curving neck. Their brown eyes are set in the side of the head to give wide-angled vision and the large ears can be swivelled in the direction of the slightest sound. The deers' acute sight and sensitive hearing alert them to any hint of

danger.

From late summer through to spring the bucks sport magnificent antlers which they later shed. These can measure up to 80cm (31in). The long spikes growing from the broad, flat palms distinguish these deer from all other British species.

Rutting season During the long days of summer, while food is plentiful, the deer eat well and build up reserves of fat to stand them in good stead for the leaner days ahead. They not only have the rigours of winter to face, but also the rut or mating season-a time of intense activity for the bucks.

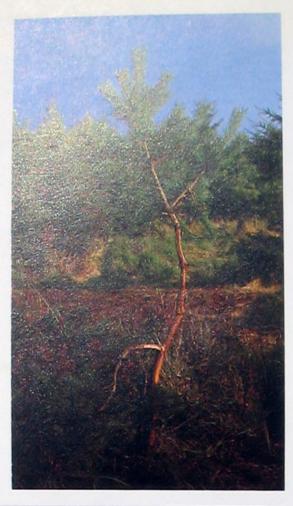
Having spent the summer away from the does and their fawns, the bucks return before

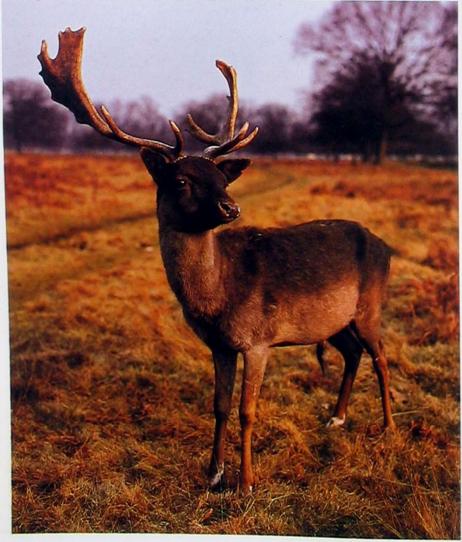


FALLOW DEER (Dama Size of adult male about 95cm (37in); weighs 50-95kg (121-209lb). Female 35-55kg (77-121lb). Breeding (rutting) season autumn; young born following summer (June). No of young one Lifespan uncertain, at least 10 years in parks. Food Tree foliage, acorns, beech mast, grasses, herbs, bramble, ivy. Predators man; foxes occasionally take fawns. Distribution Throughout England, Wales and most of Ireland; more isolated in Scotland.

Right: This young conifer has been worn down by a fallow deer rubbing its head against the tree to shed the velvet from its new antlers.

Below: The winter coat changes from dappled reddish-fawn with white spots, to grey-brown with barely discernible spots.





the rut starts in October. They parade around their territories and advertise their presence to other bucks by groaning loudly and thrashing bushes and trees with their antlers. Sometimes they will strip the bark of older trees, rub the trunk smooth and anoint it with secretions from glands below the corners of the eyes.

They also scrape the ground with their forefeet, and at this time of year you will often come across bare patches of muddy ground with hoofmarks, hairs and the unmistakeable pungent smell of rutty urine. On a still night the deep belching noise of the rutting cry can carry a long way. With their massive antlers, enlarged necks and prominent Adam's apples, the bucks are an impressive sight.

Does are attracted into a buck's territory, where he chivvies and herds them. He defends them fiercely and will fight off any rivals, groaning at and chasing them. Well-matched rival bucks size each other up and often pace the ground shoulder-to-shoulder before wheeling to meet with a tremendous clashing of antlers. Very occasionally antlers may become inextricably entangled—leading to the death of both animals.

Fawning Eight months after mating the doe seeks out a quiet place well away from other deer to give birth to her fawn. This is usually in June, when the bracken and long grasses of the woodland floor provide good cover. After licking the fawn clean and suckling it for the first time, she will move back to the doe herd or feed alone, returning a number of times each day to feed her youngster.

Does and fawns spend the summer in a separate part of the wood from the bucks. The does and their offspring often form herds after the fawns are a few weeks old, when the youngsters will gambol about, chasing one another playfully.

Maturing fawns When the fawns are about three months old, the first difference between the sexes becomes apparent: a tuft of hairs growing from the male's penis sheath. This brush becomes a characteristic of mature bucks. By the time they are six months old, some of the male fawns have quite noticeable bumps on their foreheads. These are pedicles from which the antlers will grow. When the fawns are about one year old their first antlers—stubs or slender 15cm (6in) spikes—will have formed on top of the pedicles.

In the second year the young bucks leave the doe herd and join the older bucks, to whom they are subordinate. The youngest does to be mated are about 16 months old; they will give birth to their first fawn by their second birthday.

Diet and feeding During the summer fallow deer eat the grasses and herbs in woodland glades and rides or in open pastures. You are most likely to see them feeding at dawn or dusk, although in undisturbed areas they may spend much of the day lying in a sunny field chewing the cud. Usually they choose a spot



with woodland nearby. If danger threatens they will quickly run for cover, led in single file by a doe. Sometimes when they are alarmed they adopt a strange gait—the pronk—in which they bound stiff-legged on all four feet, stop, stare around them and run off again.

Come autumn the deer move into the woodland and seek out acorns, beech mast and sweet and horse chestnuts. A good crop will help the bucks regain condition after the rut. If there is heather available on adjacent heathland, as in the New Forest, they will often move out into the open to eat that in winter.

Selective culling The bear and the wolf—once the two great natural predators—have been extinct in the British Isles for centuries. So adult deer have little to fear today except Man, who hunts them for sport and venison. However if a fallow deer herd were left alone in the wild, it would increase by about a third every year. So selective culling is sometimes necessary to protect both the deer population and the valuable woodland timber.



Above: The fawn weighs 4.5kg (9½lb) at birth. Although it takes its first faltering steps within a few hours, it tires easily and spends its first days resting. It follows close to its mother when it is two weeks old, and begins to supplement an all-milk diet with vegetation until it is completely weaned—although a fawn may be still taking some milk at seven months.

Left: If you find a young fawn lying in the grass, do not make the mistake of thinking its mother has abandoned it—you can be sure she is nearby. She will not return to suckle her offspring until you have gone.

WOOD ANTS: FOREST COLONISTS

A wood ant's nest may well contain more than 100,000 individuals so co-operation – something at which ants excel-is essential if the colony is to thrive.

Wood ants are the largest of Britain's 40 or more ant species, and have a distinctive red and black colouring. These social, colonyliving insects are divided into three castesqueens, males and workers. The queens, measuring about 12mm (½in) in length, are slightly larger than males and workers. The colony is headed by one or more winged queens whose life is mostly spent laying eggs. The wingless workers—not fully developed females—do just what their name implies: they collect food, build, maintain and clean the nest and rear young. The winged males' job in life is to mate new queens. They do not work.

Most ants in a colony are workers; they have a strong sense of co-operation and continually exchange information with each other by rubbing together heads and antennae. The colonies are stable and last for many years; the workers are long-lived by insect standards and can live for more than a year, while queens survive to 15 years old or more.

The nest Wood ants build characteristic, dome-shaped nests in pine and oak woodland. The nest, sheltering tens of thousands of ants, is often built up over a tree stump and is made of pine needles, twigs and leaf stalks. A well-established nest may be over 1m (3ft) high and 2m (6ft) in diameter. The convex thatch of vegetation forming the roof of the nest is weatherproof and very efficient at shedding rainwater. This is vitally important

enlarged chamber

chamber

cocoons

containing

side

gallery

with worker tending to larvae above ground

main gallery

gallery

since beating rain can erode nest material or, in a heavy storm, wash away the entire nest. The workers constantly remodel the dome, repair damage and honeycomb the surface with entrance holes which are plugged with twigs and nest debris at night and on cold days to keep in the heat. During the day these holes are patrolled by sentinels which allow only ants belonging to the colony to enter. Below ground, the nest continues as a large pit filled with loose earth and leaf mould. Deeper down it branches off into the soil as a series of galleries and small chambers.

The nest is constructed to provide exactly the right amount of warmth, moisture and air for the eggs, larvae and pupae which are developing inside. The interior of the nest is very humid, so damp nest material is constantly being carried from the lowest strata to the surface to dry out in the sun. Unwieldy bits of bark and twigs stay at the bottom of the pile and form a solid core. In winter the ants retreat into the underground galleries and sink into a state of torpor until spring.

Below: A cutaway illustration of a wood ant's nest. The galleries and chambers have been enlarged to show the structure more clearly.

The positions of chambers, both above

and below ground, are

constantly changing as the nest develops.

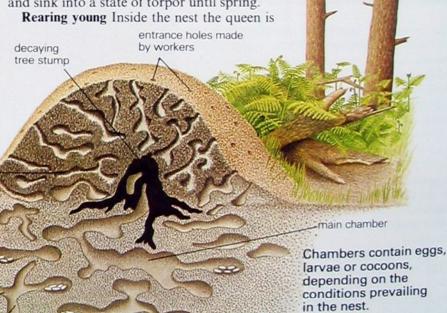
Above: A wood ant's nest. If you disturb the nest you

will see hundreds of workers

scurrying about frantically.

pupae to safety.

carrying precious larvae and



fed by workers and lays eggs which are carried away as soon as they are laid. The workers put the eggs in underground chambers to hatch and move them from time to time to different areas so they get exactly the right conditions necessary for development. When the eggs hatch, the larvae are reared on a mixture of honeydew (a sweet substance excreted by aphids) and insect grubs. Mutual feeding takes place between larvae and workers, the larvae exuding a sweet saliva in return for food. The larvae pupate inside silk cocoons; these cocoons are the 'ants eggs' on which aquarium fish are fed. Actual ants eggs are much smaller.

Starting a new colony Most of the pupae hatch into wingless workers, but some develop into winged males and queens. In May or June—when climatic and atmospheric conditions are right—the new young queens and the males leave the nest and take to the air on their marriage flight. Mating often seems to take place on the ground after the flight. One mating is sufficient for life and after it the male dies; but the fertilized queen sheds her wings—she will not need them again—and normally returns to the old nest or a neighbouring one.

The normal way for wood ants to found a new colony is for one or a few mated queens to leave the old nest with a few loyal workers. The daughter colony so formed may well be closely connected to the mother colony by trails—both underground and on the surface.

An alternative to this is social parasitism. A mated queen leaves the nest (or fails to find the original nest after mating) and locates that of another smaller ant, *Formica fusca*. She kills the resident queen and lays her own eggs in the nest. These are tended by the existing workers, and a mixed colony soon develops. However, the *fusca* ants soon die without their

own queen and the wood ants take over.

Foraging Wood ants travel far and wide in search of food, on trails leading out from the nest which may run for over 50m (55yd). The trails, about 2-3cm (1in) wide, are kept clear of debris and lead to trees where aphids and other insects can be found. The ants milk the aphids for sugary honeydew, or overpower other small insects, using their strong, sharp jaws. Wood ants do not have stings but are able to squirt formic acid as far as 15-30cm (6-12in) from the tip of their abdomen which is thrust forwards between the legs. The workers drag their prey back to the nest where it is both eaten and fed to the larvae. They also feed the larvae and the queens with the regurgitated juices. The ants favour larvae and adult moths, midges and sawflies as prev. Many of these are serious forest pests, so forest wardens encourage the establishment and preservation of wood ant colonies. On average wood ants collect one and a half times their own weight of food each day. In a large colony consisting of as many as 100,000 individual insects, as much as a kilogram (two pounds) of food can be gathered daily.

Embattled ants When food is plentiful the workers of separate colonies keep to their own territory. However, when food is scarce they may invade each other's hunting grounds. Fierce fighting can then occur between rival workers, resulting in the death of many thousands of ants. Battles often last for days or even weeks, but are discontinued at night when the workers return to their own nests.

Wood ants are fortunate in having few enemies. Woodpeckers and some game birds eat them, despite being bitten and sprayed with acid, and some spiders of the Dysdera and Dipoena families wait on vegetation overhanging ant tracks and drop on workers.



A queen wood ant. The queen keeps her wings until after she mates, then sheds them.



A male wood ant, produced from an unfertilized egg. His sole function is to mate with a queen.



A worker ant with cocoon; a worker, though it never mates, can lay unfertilized eggs.

Below: A pair of wood ants carrying a piece of bark back to the nest.

Insect defence

Wood ants don't have a sting, but defend themselves by spraying jets of concentrated formic acid at enemies. Similarly, bombardier beetles fire a chemical—a gas expelled with an audible explosion. Those with stings, like bees, use them for defence, while others ward off attackers by biting with their stout jaws.

Many moths are dullcoloured for camouflage so they can't be seen on bark or twigs. Other insects have bright colouring which warns of danger, as with wasps which sting, or of a nasty taste, such as ladybirds.



FINDING REFUGE IN THE GARDEN

With over 16 million gardens at its disposal it is not surprising that our wildlife takes advantage of this widespread habitat.

A mature garden may play host to some 60 bird species, 300 plants and thousands of different insects so long as gardeners don't overdo the pesticides and fertilizers.

Of all the habitats around us none is more frequented—and yet more likely to be over-looked as a haven for wildlife—than the garden. Occupying over a thousand square miles of Britain's land area, gardens represent a significant resource not only for the house-holder but also for the various plants and animals that live there.

Gardens are enormously variable in the sort of opportunities they offer wildlife. Most, however, are suburban, and so can quickly become colonized by the flora and fauna in the countryside nearby. Where two habitats meet, the border zone—in this case between the concrete jungle and the surrounding countryside—often has a specially rich assemblage of wildlife because it provides some of the features of both habitats and draws recruits from each.

Stocking the garden A newly plotted garden will contain little more than the few invertebrates-earthworms and snails, for examplethat inhabit any patch of bare soil. A garden put down to lawn offers little more, but if the gardener progressively introduces herbaceous plants, vegetables and shrubs, the habitat quickly increases in complexity and is able to support a surprising diversity of wildlife. Many herbivorous insects and other invertebrates are very specific about what they like to eat. Each invertebrate is, in turn, preyed upon only by certain sorts of other animals, so that even a small mixture of plants can generate quite an elaborate series of food chains.

The sap of the broad bean, for example, is the lifeblood of hosts of aphids which, gorging themselves to excess, secrete the surplus in the form of sugary honeydew. This now attracts ants which exploit the honeydew as food. The broad bean is not entirely at the mercy of the aphids, however, for ladybirds and their larvae are voracious aphid consumers. Tits will also feed on the supply of aphids.

The richest garden habitats are usually ones that have been cultivated long enough to boast mature shrubs and trees in addition to the 'field layer' of plants below. The pooled effect of lots of neighbouring gardens, each with individual ideas and input of effort,

creates a patchwork habitat whose sum is more complex than the parts. Some simple invertebrates such as slugs find all their needs in one strawberry bed while other creatures, like birds, have to range over several gardens to gain their livelihood.

Exceptional resident With so many different habitats blended into one, there are few animals we may call typical of gardens in the sense that they are more common there than anywhere else. One, however, is the blackbird. Over the last 150 years, the blackbird's preferred habitat has shifted to gardens and parks where it lives at much higher density than it does in its traditional woodland haunts.

The garden contains fewer blackbird predators. In the wood, weasels, squirrels, hedgehogs and rats all raid their nests, whereas the cat is the worst threat in the garden. Blackbirds also seem to survive better in gardens during the winter, mainly because householders have become very conscientious about feeding birds. More recently collared doves have also invaded well-vegetated gardens and magpies are infiltrating some







A varied and luxuriant garden such as the one above supports more kinds of plants and insects than a piece of countryside of the same size. The shrubs and trees provide shelter for birds, and the long grass for small mammals such as shrews. The neat and very attractive garden, left, probably will not support as many species as the one above. The colourful flowers will certainly attract nectar-seeking insects in summer, but the lack of shrubs or other shelter makes it difficult for other animals to set up home. Another disadvantage of a tidy garden is that if you do not leave decaying matter about, you have to keep adding nutrients to the soil.

suburban areas, notably in Dublin where householders fear they will scare off the more familiar garden birds.

Once a male blackbird succeeds in annexing a garden territory he may be resident for as many years as he survives. Other birds such as robins and tits may do likewise, but it is very difficult to separate genuine residents from brief visitors. In winter, for instance, the British Isles are invaded by legions of continental blackbirds, starlings, and finches, and the birds we see feeding on the lawn are as likely to be breeding in Poland next summer as in the holly bush at the end of the garden. Similarly, studies show that hundreds of different tits pass through a single garden in the course of a winter, though without individually ringing birds the impression is of seeing the same few tits each day. Gardens thus offer permanent quarters for some animals, a temporary refuge for others.

On the move Many insects, especially pollen and nectar feeders, are the most fleeting of visitors. In a painstaking 5-year study by Denis Owen in a Leicester garden, a remarkable tally of 11,000 individuals of 21 butterfly species was caught, marked and released. Few were recaptured in the same garden proving the great mobility of butterflies and many other winged insects through suburban districts. A notable exception is the honeybee which, having discovered a good herbaceous border, will return to feed there again and again.

While the particular blend of vegetation is largely under the gardener's control, much also depends on where the garden is situated: whether in the north or south of the country, how close to the sea, whether it commands a sunny aspect, and so on. A factor of overriding importance is soil type. Snails, for example, flourish only in areas where a chalky or limestone soil yields the calcium they need for building shells. A widespread survey of gardens in the West Midlands, where much of the soil is sandy, showed that

Right: The goldfinch often nests in gardens, choosing a lofty site such as a tall apple tree. In autumn you may see flocks of these birds feeding on the seeds of various weeds, particularly thistles.

Below: Soldier beetles, here seen mating on the head of an umbellifer, are attracted to the flowers in an herbaceous border, where they also prey on smaller insects.







Left: The startling colours of the tiger moth warn birds of its unpleasant taste. Its hairy caterpillars, known as 'woolly bears', feed on weeds such as dock and nettles

Below: By leaving some bits of decaying plants around the garden, a gardener may help to spare his seedlings from the attention of garden snails, which have broad vegetarian tastes.



the garden snail, which has a particularly thick shell to construct, was virtually absent. Many lime-loving plants, such as vetches and the hoary plantain, likewise have a patchy distribution as weeds in British gardens.

Garden props What also helps to mould the garden's character is the variety of artefactswalls, outbuildings, paths and fences, for example-that the gardener introduces. These offer a wealth of opportunities: nesting sites for birds, shelter under stones for smaller animals and crevices and dry sheds for hibernation. Walls provide a surface for mosses and ferns to cling to, and the dry stone wall in particular an internal labyrinth for mice, voles and hunting wrens. Often these garden structures resemble some feature that the animal has been accustomed to using in the wild. Great spotted woodpeckers, for example, periodically explore old clothes poles, as they would a tree-trunk, for grubs; the warmth of the compost heap attracts bumblebees to build their nests there and toads to overwinter, while the doorstep provides an occasional anvil stone for thrushes to crack open the snails they find along the foot of the walls. The garden pond is colonized at an astonishing rate by aquatic life, including frogs, toads and newts in search of spawning sites. Birds visit it to drink and bathe while insects swarm over the surface, tempting swallows and wagtails and the occasional dragonfly.

The role of the weed Apart from the plants the gardener contrives to establish on the soil, there will be many interlopers from outside. So strong is the propaganda against weeds that people think of them almost as a separate class of plants, somehow having an inferior pedigree to cultivated varieties. However, it is the weed species' capacity for survival as either fast-growing annuals (eg chickweed and shepherd's purse) or seemingly indestructable perennials (eg dock and dandelion) that has guaranteed their vigorous history of success.

Some, such as clover and bird's-foottrefoil, enrich the soil, while others are specific food plants for insects and, when they seed, for small mammals and birds. Nettles, for instance, are the staple diet of the caterpillars of several butterflies, notably red admirals, tortoiseshells and peacocks and are also eaten by numerous moth caterpillars, including the exotic garden tiger. The creamy flower heads of umbellifers like cow parsley and hogweed are sought for their nectar by beetles and flies, and in late summer these venues are daily the scene of minor dramas if one cares to watch. Occasionally a wasp may hurtle in to snatch and carry off a hapless hoverfly, devouring it at leisure in a quiet spot. All in all there are sound reasons for controlling weeds, but a compelling case for keeping a wild patch somewhere in the garden. Too much pesticide may kill insects which are vital for the pollination of some flowers.

WATERSIDE WILLOWS

Our two largest native willows, the white and crack willows, are often deliberately planted by man to help prevent water eroding the soil alongside soggy river banks. They thrive too in damp valleys and fens. There are more than 130 species of willow in the world, at least 15 of which are native to the British Isles. They include sallows, osiers and many garden species, as well as white, crack and cricket bat willows, three of our most common species.

White willow In its typical form this willow has steeply ascending branches which develop into a narrow crown. The overall grey-whiteness of the tree's foliage gives it its name. The long slender leaves with sharp-pointed tips are light green on top and covered with a thick down underneath, giving the leaves a silvery sheen. The dark grey bark has a close network of deep fissures and ridges and is rich in salicin, a chemical used in the tanning

White willow at Wicken Fen in Cambridgeshire. It gets its name from the grey-white colour of its foliage. In its typical form, the tree has steeply ascending branches.





White willow (Salix alba).

Deciduous, native, grows to 25m (80ft). By streams, rivers, marshes, damp woods. Flowers April-May, fruits June.

male catkins (3.5-5.5cm)
White willow

female catkins showing white-plumed seeds



of leather and formerly for making asprins. The twigs are silky when young and quite tough, in contrast to the crack willow which has fragile twigs.

The dangling cylindrical catkins start to develop in spring at the same time as the leaves. The male catkins produce large quantities of bright yellow pollen which is carried by the wind or insects to the green catkins of the female tree.

Once pollinated, the female catkins develop into small seed capsules which ripen and eventually split, releasing large numbers of white-plumed seeds; these in turn are dispersed by the wind. They lack a protective layer of endosperm (or albumen, a substance like the white of an egg) that seeds of most other tree species possess. They must find a suitable place to germinate within a few days or they die. They need very moist conditions to germinate successfully, which explains why adult willows are so often found in watery surroundings. Once the plants have started to develop, their water requirement is comparatively small.

Crack willow gets its name from the fact that its twigs are extremely fragile and snap easily. The coarsely ridged and fissured bark is dull grey in colour, and the twigs bluishgreen. The leaves, which are narrow with coarsely toothed edges and tapered to an asymmetrical point, are glossy green on top and bluish underneath. The catkins are drooping and cylindrical and appear in April at the same time as the leaves and slightly earlier than those of the white willow; male catkins are yellow and female catkins green.

The crack willow spreads partly by the dispersal of its seeds in the same way as the white willow, and also by its twigs. These snap off easily and are carried downstream by the river current; they lodge and readily take root in mud banks or shingle. In common with all willow species, the crack willow grows very easily from cuttings and you often see willow fence posts sprouting new growth, or willow tree stakes outgrowing the trees they were intended to support.

Individual willows are extremely difficult

Above: Crack willow (Salix fragilis). Deciduous, native, grows to 25m (80ft). Common in damp places, by streams, rivers. Flowers April, fruits May-June. Below: A peaceful riverside scene—crack willows at Bourne End in Hertfordshire.



to identify and you may have problems deciding which are crack and which white, since they hybridize freely, producing trees which look very similar or intermediate to their parents.

Also, willow leaves can change considerably in shape as they mature from spring to summer, and, confusingly, two willows of the same species may have quite different leaf shapes. (The surest method of identification is to look at the flowers and leaves together.) Each tree produces either male or female flowers (catkins) and you will need to be able to recognise both to distinguish between the species.

Cricket bat willow is the commonest hybrid between the white and crack willow and it probably originated in Suffolk. It can be distinguished from the white willow mainly by its leaves which are grey on the underside. It is extremely fast-growing and its wood is tough, pliable, light and ideal for making cricket bats. One full-sized tree makes at least two dozen bats.

Willow hybrids between other species are

cultivated in gardens and towns for their decorative appearance; these include the coral bark, the silver and the golden willow with its attractive variant the weeping willow, probably the most familiar member of the willow family in this country.

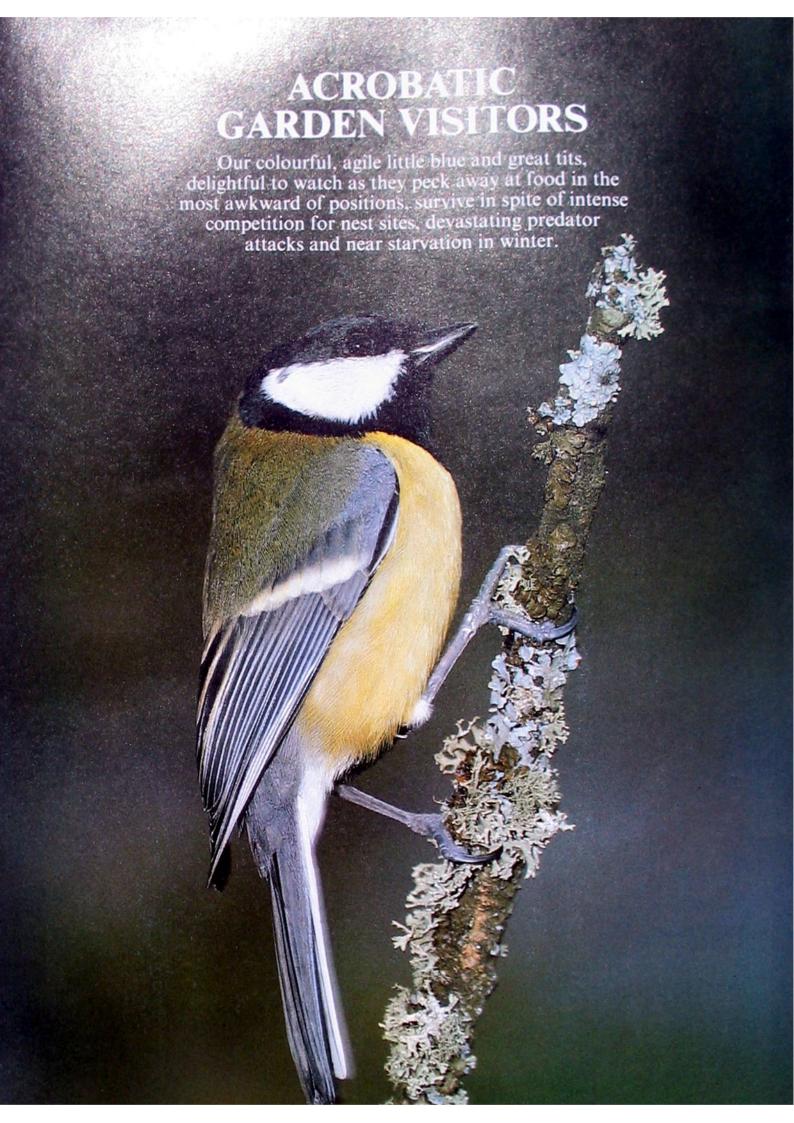
Willow timber is a versatile wood because it is light and resilient. Willows were often pollarded to produce straight branches sprouting directly from the top of the trunk, well out of reach of grazing animals. Pollarding was especially important in areas like the East Anglian Fens where little or no other timber was available. It is no longer widely practised. You can, however, often see trees that have been pollarded long ago now growing unchecked. They are common alongside many river banks in the south-east of England.

Host to wildlife Many insects depend on willow leaves for their food. Aphids often cause extensive leaf damage by excreting honeydew, which encourages mould. You also find leaf beetles, weevils, sawflies and gall wasps on willow trees.



Above: Pollarded crack willows near the Thames at Wallingford. The willows in the background have been allowed to grow in their natural dome shape.





Blue and great tits, both colloquially known as tomtits, are popular garden birds which visit bird tables regularly in winter. Both are widespread throughout the British Isles and you'll see them in deciduous woodland, scrubland, hedgerows and farmland everywhere. The blue tit is an agile, aggressive, always excitedly active little bird which specialises in hanging at awkward angles to feed, while the great tit, larger than the blue and twice as heavy, often prefers to feed on the ground like a finch. Male and female blue tits are very similar in appearance. Among great tits a distinguishing feature between male and female is the black line which runs down the centre of their primroseyellow breasts. This is faint in the female but very bold and wide in the male.

Seasonal foraging In summer blue tits feed mainly on insects, searching for them at the tips of twigs and shoots. In winter this diet is supplemented with occasional nuts and seeds. Since insects are neither active nor easily visible in winter, blue tits have to spend considerable time peering and probing round buds and under flakes of bark to find hibernating adults and larvae. If you observe the apparently aimless acrobatics of a blue tit through binoculars, you'll see that it is in fact purposefully searching every potentially rewarding nook and cranny.

In the garden the boldness and agility of blue tits as they attack peanuts hung in a plastic mesh sock is a delight to watch. They feed on almost everything put out on a bird table except bird seed, but above all they prefer nuts and fat.

Great tits eat much the same food as the blue, but take more vegetable food in winter particularly seeds and nuts which have fallen to the ground. In fact, great tits are so fond of nuts that 'intelligence tests' have been devised where they demonstrate their inquisitiveness and learning ability by pulling up threads with a nut on the end, or prising open matchboxes to get at the nuts concealed inside.

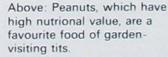
Attacking milk bottles Sporadic outbreaks of tits pecking open the cardboard tops of milk bottles to drink the cream were first reported in the early 1930s. The habit rapidly spread to become nationwide—an excellent example of how quickly newly learnt skills can spread throughout a population. The post-war transition from cardboard to aluminium foil tops presented the tits with no problems, and in many rural areas milk bottles now have to be protected as a matter of routine.

Feeding for breeding The breeding season for great tits begins in late March and for blue tits in early April. To get into peak condition for egg laying as early as possibleearlier broods tend to be larger and healthier than later ones-the female must eat prodigiously. In the three weeks before laying begins, she puts on weight at an extraordinary rate, increasing her normal weight by at least a half and sometimes more. Then, over 10 or 12 days, she produces almost her own weight in eggs, laying one each day. This remarkable feat cannot be achieved by the female unaided; the male must feed her. You may well see a pair of tits side by side on a branch. the male offering his mate a beakful of caterpillars which she accepts with rapidly fluttering wings. This behaviour-called courtship feeding-may be essential if breeding is to be successful.

The female tit does all the nest-building, choosing a hole or crevice in a wall, tree or garden nestbox. The nest-a cup of moss, grass, wool, leaves, roots and spiders' webs-is lined with hair or feathers.

All eggs in one basket In summer, in deciduous woodland, both great and blue tits often rely heavily on just one species of insect as food for themselves and their young. In oak woods this is the winter moth which frequently produces huge numbers of caterpillars. The parent birds need to synchronise the maximum food demands of their young with the single, short-lived peak in the caterpillar food supply. They therefore produce a single large brood each year. This is unlike most other small birds which rear two or even three broods a year and thus have two or three chances if anything goes wrong. It is almost literally a case of the tits putting all their eggs in one basket!





Left: A glossy black crown and white cheeks clearly identify the great tit.



over the British Isles.

n all

Left: The aggressive little blue tit raises its cobalt blue crest and droops its wings in characteristic gestures that are both courtship and threat display.



One in ten survive In spring each breeding pair of tits is generally composed of one adult bird which bred the year before and is at least 21 months old, and one young bird which is about nine months old and breeding for the first time. One half of each breeding pair dies each year. For the population to remain steady, only one youngster would need to be reared per pair to replace the dead adult. On average, however, ten youngsters leave each nest in summer. This means that nine die by the following spring-a staggering 90% mortality rate. Gruesome though it sounds, this is an insurance against catastrophe and is quite usual in the bird world. Indeed, if one extra youngster per brood were to survive each year, the whole countryside would soon be overrun by hordes of tits eating up all available resources and precipitating a disastrous drop in the population.

Plenty of predators The high mortality rate is largely the result of natural causes, especially starvation, since inexperienced young birds have difficulty finding enough

food in winter. Also, at the start of the season, competition for nesting holes is fierce. Larger birds such as the starling may oust tits from the bigger holes, and tit may oust tit from smaller ones. The larger great tit does not always succeed in evicting the smaller but more aggressive blue. Tree sparrows can squeeze through an entrance apparently only



Above: A parent blue tit bringing a caterpillar to its young. The nest is only relatively secure from predators. Weasels and woodpeckers take a large toll of eggs and young chicks every year.

Left: A clutch of great tit eggs. The blue tit's eggs are slightly smaller but very similar in colour. In both species the female incubates the eggs by herself for 12-16 days, often fed by the male while she is sitting on the nest.

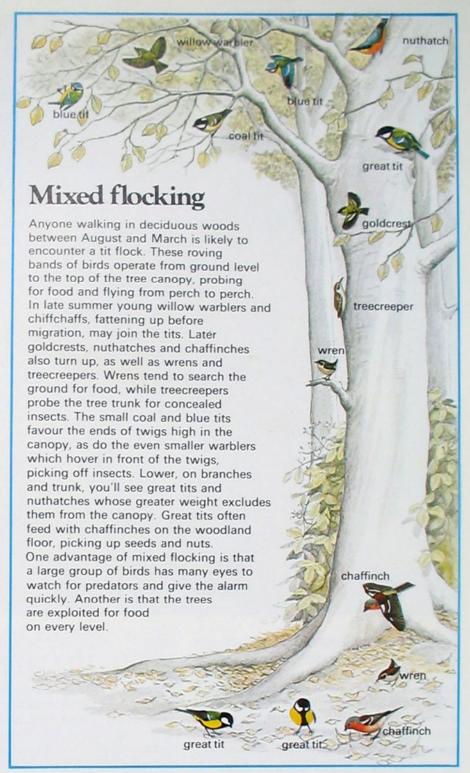
Right: A brood of blue tit chicks in their down and feather-lined nest. The youngsters are fed by both parents and fledge in about 15-23 days.

just large enough for a blue tit, and often build their untidy nest on top of a clutch of tit eggs or, as tree sparrows are late nesters, even on top of a flourishing brood of chicks.

Predators also play a significant part in the high mortality rate, and may account for a third or more of the deaths. Great spotted woodpeckers have a taste for tit eggs and young and can easily open up a nest hole with their strong beak. Woodpeckers capitalize on the fact that well-grown tit chicks are alerted by a shadow falling across their nest hole and jump up to the entrance to grab the expected food from a returning parent. As soon as the unfortunate chicks appear, the woodpecker catches them. In the early days after fledging, the inexperienced youngsters may fall easy victims to hunting sparrow-hawks.

Strangely enough, wood mice and sometimes voles climb trees readily and enjoy any eggs they happen to find. The prime predatory mammal, however, is the weasel, which can squeeze through the nest hole without much difficulty. Often the weasel will gorge on young birds to such an extent that it has to sleep off the meal until it slims down enough to squeeze out again. Weasel predation is particularly high in summers when the weather is poor and the young tits are underfed. The hungry chicks squeak noisily for more food and are heard by patrolling weasels on the look-out for prey.

Irruptions The general trend in tit numbers is more or less steady, but there are some fluctuations from year to year. Often, after a series of good summers and mild winters (especially on the Continent), mortality is lower than usual and consequently tit numbers far higher than average. In this situation, the sudden onset of a severe winter, or a shortage of natural food, produces a massive westward movement-called an irruptionas hungry birds move about in search of food. When these hordes cross the Channel, autumn numbers in the eastern counties of England reach spectacular levels. Strange reports sometimes appear of tits eating the putty round window frames and even entering houses and tearing strips of wallpaper off





the walls. Irruptions occur irregularly, perhaps only once a decade.

Ringing results show that most of the birds in an irruption are of Continental origin, coming from as far away as eastern Poland. Winters in mainland Europe are generally more severe than in much of Britain and Ireland, so Continental blue and great tits migrate south and west in autumn to escape climatic hardship and to find easier feeding. British birds, on the other hand, tend to stay close to home, and, although they may roam around several parishes, rarely make journeys of more than 30 miles. Many establish a circuit of known good feeding spots and visit each in turn.

WHAT KIND OF CORN' IS THAT?

Golden fields of shimmering corn can look rather similar from a distance. But get closer and you can easily identify the stubby upright ears of wheat, the long-beared ears of barley, the shorter beards on the ears of the less common rye and the dainty open heads of oats which thrive on the poorest soils.



Cereals, which are cultivated grasses, provide the staple food in nearly every part of the world, from the steamy tropics to temperate zones, and even inside the Arctic Circle. Their overwhelming importance stems from their ease of cultivation and consequent low price. The edible product is the seed, or grain, which is rich in starch and contains useful amounts of proteins, B vitamins, minerals and vital fibre. Many grains also contain small amounts of fat.

Wheat and barley were certainly being grown about 9000 years ago in the Middle East, in the so-called Fertile Crescent—the Nile valley and the valleys of the Jordan, Tigris and Euphrates rivers. Many of the earliest civilisations developed in this part of the world, and it is often said that civilisation might never have evolved without cereals. Until man learnt to cultivate crops, he always had to be on the move in search of food.

A little under half the arable land in the British Isles carries cereals in any one year—a total of about nine million acres. Production is highly mechanised and the crops are grown in vast, open fields to facilitate the use of

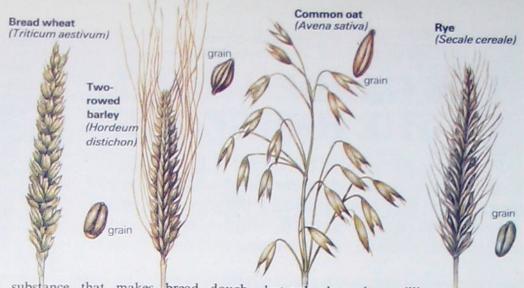
today's huge combine harvesters. The cereals are sown in autumn or spring; as they grow they form green carpets over the land. Each seed gives rise to several shoots, and each shoot grows up to produce an ear of grain; as the shoots ripen, they turn golden yellow. When the wind ripples through the crop the fields seem to move like the surface of the sea.

Barley is our most important cereal and about five million acres are devoted to it at the present time. The ears are surrounded by long bristles called awns. This feature distinguishes barley from most types of wheat (although there are some awned varieties of wheat known as bearded wheats). There are three spikelets at each joint of the ear, although only one may contain grain. When the ears ripen they hang downwards on their relatively soft stems. Wheat straw is tougher, and the ears are usually more or less upright.

Barley ripens more quickly than other cereals and is less susceptible to cold and drought than wheat. It thrives well in the cooler climate and drier soils of eastern England. Barley flour contains little gluten. Above: A field of ripening barley near Malton in north Yorkshire. The drooping ears indicate that the crop is ready for harvesting.

Right: A field of oats being harvested in Kent. Oats are easy to recognise by their branched open heads. The grain forms a nutritious starchy basis for products such as porridge oats.





the substance that makes bread dough elastic, and so it cannot be used for ordinary bread. Most of the crop is used for feeding livestock or to make malt, an essential ingredient in brewing beer.

Barley was once sown mainly in spring, but about half our barley crop is now sown in autumn. Wild oats and other weeds can be a problem with autumn-sown barley, but modern selective weedkillers deal with them quite easily. Autumn-sown barley is harvested earlier than spring-sown crops and has better malting qualities. The crop is fairly resistant to disease, but the loose smut fungus sometimes attacks the developing grain, causing it to burst open and release masses of black sooty spores. Wind is probably the greatest problem, especially when combined with rain, for it flattens the crop and prevents proper drying. The flattened stalks are also more difficult to harvest.

Wheat In terms of annual production, wheat is the world's most important cereal,

but only about three million acres are sown annually in the British Isles. All cereals require plenty of moisture and sunshine, but wheat needs rather more of both than barley and is mainly grown on the heavier soils of southern and central England.

Three main species of wheat are grown in the world today. The commonest, bread wheat, is almost the only one grown in the British Isles. Only a small amount of our wheat, however, is used for bread-making (combined with gluten-rich Canadian wheat). The rest goes for animal feed and for industrial uses, such as the manufacture of starch and alcohol.

Wheat is sown in late autumn or early spring and harvested in early or late summer respectively. The ears are rather stout and knobbly; and as wheat has a tougher stalk than barley it suffers less from wind damage. Otherwise the crop faces the same problems as barley—weeds, fungal diseases, and soil pests such as cockchafer grubs and leather-jackets. In summer both crops are also attacked by aphids and by hoardes of thrips—minute black or brown insects that feed on the developing ears and then leave in vast swarms as the ears ripen. They are often called thunder flies because they tend to fly in thundery weather.

Rye and oats were developed more recently than wheat and barley. They were probably weeds in the other cereal crops, but as agriculture spread to cooler regions they were cultivated in their own right because they survive well in cold climates and poor soils. Rye ears have long awns and resemble barley, but they do not droop when ripe. Most of our rye is grown in the far north and on the sandy soils of East Anglia. Its flour can be made into bread, but it is dark and strongly flavoured. Some rye is used in crisp-bread, but most British rye goes for animal feed.

Oats are easy to recognise for their loosely branched flower heads. Like rye, they can grow anywhere, but are usually confined to the harsher climate of the north. Oat grains are nutritious, but the flour lacks gluten and the bulk of the crop is used for feed.



THE GARDEN HOME OF THE HEDGEHOG

Search your garden or back-yard at night with a torch and you may find several hedgehogs (when you thought you had none) pursuing the plentiful garden pests. They are determined foragers, burrowing under obstacles and even climbing over wire fences.

The hedgehog is a familiar inhabitant of town parks, gardens, cemeteries, railway banks and waste ground. Suburban gardens in particular provide the hedgehog with an ideal summer and winter home under compost heaps, behind sheds, below hedges and tucked away in odd corners. Its small size and nocturnal movements make it inconspicuous, so much so that many people have these spiny creatures in their gardens without even realising it. There is plenty of invertebrate food in gardens such as worms, slugs and beetles. The hedgehog also plunders bread put out for birds and bowls of milk left for cats.

Friend or foe Hedgehogs may cause some



irritation to game keepers-by eating game bird eggs for example; but their presence in urban areas is wholly beneficial. They may even be the cheapest and most effective form of pest control, because they prefer to eat those animals that gardeners are glad to be rid of-beetles, slugs, worms and caterpillars. Hedgehogs also eat millipedes which many predators find distasteful, and snap up earwigs when they can. Strangely, however, they avoid the numerous and easy-to-catch snails and woodlice.

Poisoning problems Gardeners may be doing themselves and the hedgehogs a serious disservice by using artificial means to get rid of pests, rather than relying on the natural



resources of the hedgehog to do the job. The use of various pesticides results in the slow poisoning of invertebrates, which are then eaten by hedgehogs. They in turn accumulate small doses of poison which build up in the animal's fat being stored during the autumn in readiness for hibernation. As the hedgehog ekes out its fat reserves over winter, the poison is released and many hedgehogs must surely suffer as a result.

Slug pellets are another potential hazard. These are much more poisonous to slugs than to mammals, and are therefore regarded as relatively safe. Hedgehogs, however, are likely to eat any sickly or poisoned slugs they come across, even if not the pellets themselves. Although not a lethal dose of poison, the small quantities (along with other garden chemicals eaten accidentally) may be enough to cause serious internal damage to the hedgehog.

There is a high probability that both types of poisoning lead to death; but nobody seems to have studied this danger for hedgehogs, whereas the effects of pesticides on birds and pets are well-publicised. Hedgehogs accumulating poison may account for the sickly ones found wandering about gardens in a dazed fashion in broad daylight. It could explain such curious hedgehog behaviour as the running in circles that is often reported, or the staggering gait that appears to be a prelude to death.

Breeding and birth You may come across courting hedgehogs in gardens, particularly on warm summer evenings. They make a loud repetitive snorting noise which you can hear from a considerable distance. The male continuously circles the female-perhaps for upwards of half an hour-often making a circular track in the soft earth of a flower bed or lawn. As in any other four-footed mammal,

HEDGEHOG (Erinaceus europaeus). Also called 'urchin'.

Size adult male weighs 800-1110g (28-40oz), body about 26cm (10in); female generally smaller and weighs 500-700g (17-25oz).

Colour brown; rarely albino. Spines on the back and sides dark brown with lighter tips; head and belly have coarse hairs.

Breeding season Young born May-July; late litters up to September. Gestation period 31-35

Gestation period 31-35 days

No of young 2-7; 20% die before leaving nest. Lifespan Average under 2 years, maximum 8 years. Food Worms, caterpillars, beetles, carrion; almost anything available at ground level.

Predators Few because of spines. Fox, badger, dog take some (especially babies); tawny owl, pine marten, polecat. Gamekeepers and motor cars kill far more. Distribution Throughout mainland Britain and Ireland, except wet places and mountain tops. Common on arable farmland, urban areas.

Far left: The mother looks after her babies for a month or so; the male takes no part in rearing the young. Although babies are born with only about 100 pale spines, the adults have from 3000 up to 7000.



the male mounts the female from behind. With so many spines around, both hedgehogs have to be very careful when mating; so the female spreads herself close to the ground, and her spines are flattened against her back.

This is the only time male hedgehogs get involved in breeding; the female performs all the chores of raising a family. In a secure nest she has built herself, she gives birth to a litter of usually four or five babies, which have only a few, pure white spines. Litters are born from May till October; some mothers that have one early litter may go on to produce a second one later, although this has not yet been proved.

Mother and young Tidying-up operations in the garden often accidentally uncover nests with babies. These should not be disturbed if at all possible; if the mother is alarmed at this time, she may often eat, or partly eat, her offspring or abandon them. This is less likely to occur when the babies have grown a few brown spines after a week or so. Should the nest be disturbed at this stage, the mother often carries her family one at a time, by the scruff of their necks, to a new home.

About 20% of baby hedgehogs die before they leave the nest. Those in large litters are particularly at risk-presumably because the mother cannot feed them all adequately. The mother looks after her young for four or five weeks, after which she may lead them from the nest on feeding excursions-a charming procession of prickly little litter mates. From here on the individuals break away to live solitary lives.

Territory Nobody knows exactly what happens once the family has dispersed, because few studies have been made of hedgehogs in the wild-despite their numbers and familiarity. However, it is quite likely that some (especially females) stay put in favourable spots, while others wander widely, possibly spending much of their lives as

One way to study such behaviour is to mark hedgehogs, giving each an individually recognisable identity. This not only enables us to discover a little about where hedgehogs go, but also reveals something of their social activity. Once the garden hedgehog is marked 'it' frequently turns out to be six or more. An attendance register can be kept, noting which animals come to a feeding bowl each night. Many questions may be answered by observing marked hedgehogs, such as which is the dominant member in the feeding heirarchy. Some always eat their fill first, while others wait in the shadows until the rest have finished.

About one-third of the population dies each year; the mortality of juveniles is very high during their first winter. Not much is known about survival rates, but most hedgehogs probably do not live beyond three years, and maybe one in 300-400 survives seven years.

Nevertheless hedgehogs fare better than most small mammals because they are wellprotected from predators by their spiny coat. Owls, foxes, badgers, weasels and other killers tend to leave them alone. Motor cars and game keepers kill more hedgehogs than any natural predators. But the greatest threat to the species results from the physiological stresses of hibernation (described in Issue 2).

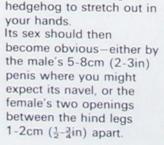
Inner-city survivors Hedgehogs remain widespread and numerous despite these threats, plus the problems of pesticides. Their willingness to eat a great variety of food, and to live in man-dominated environments, means that they are not threatened

Right: Hedgehogs usually tolerate a dim light, so you may spot them with your torch as they go about their nocturnal feeding in the flower beds. Hedgehogs also appear to have a good memory for free food such as bowls of milk (below), because many will return after hibernation to where they fed the previous year. The creatures have been known to dig under obstacles like fences or climb over them-even a 2m (61ft) chain-wire fence.



Sexing hedgehogs

To tell a male hedgehog from a female, you need to look at the underside (right). A hedgehog will curl up into a ball if it feels threatened; so to get the animal to unroll, first support it in both hands-wearing gloves. Gently shuffle the hedgehog until its foreleas are on your right hand and hind legs on the left. Then slowly raise your right hand and squeeze the animal's spiny back against your jacket, gently forcing the hedgehog to stretch out in your hands. Its sex should then become obvious-either by the male's 5-8cm (2-3in) penis where you might







by the march of progress, characterised by the urban sprawl. Hedgehogs can in fact survive deep in the heart of our cities, not just around the suburban fringe. For example there are hedgehogs living in many Central London parks, spreading from there into adjacent streets and gardens.

The densely built-up inner suburbs of London (such as Streatham, Deptford, West Ham, Highgate, Willesden) have thriving hedgehog populations, even though they are only a few miles from the city centre. The same is true of residential areas of other major cities, including Bristol, Manchester, Norwich and Edinburgh.

The hedgehogs' stoic adaptability has helped them survive for over 15 million years—far longer than the woolly mammoths and sabre-toothed tigers that were once their contemporaries. When so many species are threatened with decline and possible extinction today, it's reassuring to know that hedgehogs will be an endearing feature of gardens and other man-made habitats far into the future, just as they are now.

The hedgehog flea

Garden hedgehogs are often blamed, unjustly, for passing on fleas to domestic pets. The hedgehog's reputation for being flea-ridden is welldeserved. But these fleas are all of one type-they are adapted to life among the thousands of hedgehog spines. The hedgehog's skin is such a difficult place to inhabit that only one speciesthe hedgehog flea Archaeopsylla erinacei-manages to live there. These fleas occasionally bite a human, or get on to another animal; but they soon drop off to find another hedgehog. If a dog or cat is plagued with a lot of fleas, it almost certainly got them from another dog or cat, because both animals have their own particular species of fleas, which are common enough-but never found on hedgehogs. So the often-made suggestion that fleas are exchanged between hedgehogs and domestic pets is not founded on fact.



ADAPTABLE WETLAND PLANTS

Some plants can grow alongside streams, in ditches, damp meadows and soggy woodland, and equally well in fields and on waste ground. Horse-radish and butterbur are good examples of this type of adaptable plant. One is famous for its roots; the other has a fascinating sex life.

Waterside plants live in two environments at once: some parts of the plant are submerged in the water, which is often fast-flowing, and other parts are in the dry air. So it is not surprising that such plants may develop two or more leaf types to suit the different conditions. When a single plant species has many types of differently shaped leaves, this phenomenon is known as heterophylly (from the Greek word for 'different leaves').

The plants illustrated here are inhabitants of pond margins or stream banks, and their type of heterophylly is less spectacular than that of deeper water plants.

Take the great yellow-cress. For most of its two metre $(6\frac{1}{2}ft)$ stem the leaves are not jagged or indented (entire), with no more than minute teeth at the edge. But at the base, which is sometimes covered by water, the leaves can be so deeply cut that they have a feathery appearance.

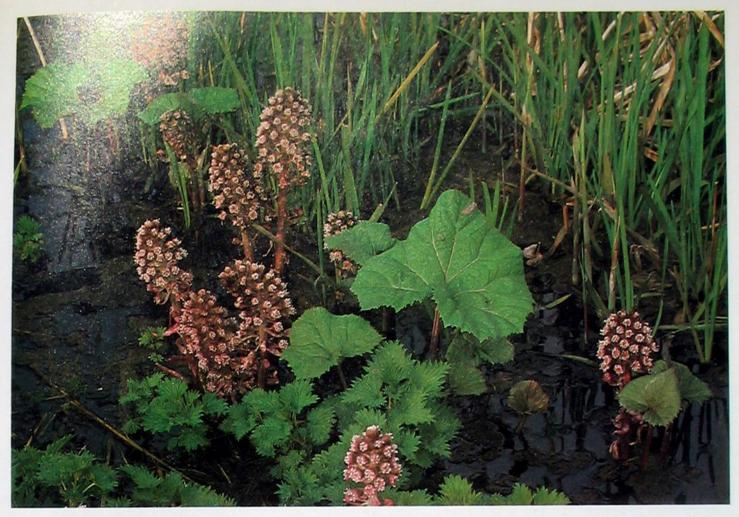
Horse-radish, too, even when growing on dry ground, has comb-like lower leaves and entire upper ones. Divided leaves like this are probably better able to resist buffeting when submerged in water.

Horse-radish thrives in the muddy conditions of streamsides, its stout, deep roots spreading easily through the wet soil and throwing up new shoots as they go. It was originally a Middle Eastern plant, introduced to Britain in the 15th century and now quite at home here. It can be found not only by streams but on most types of waste ground, by fields and on roadsides. In fact it is often so prolific that if it is growing in a garden it soon spreads and chokes plants with less sturdy roots.

Although horse-radish is now used exclusively as a condiment, a hot liquid made from the roots used to be drunk to keep out the cold. For this reason it is often found

growing near old coaching inns.

Brooklime leaves make rather a bitter salad but are rich in vitamin C. In sunny weather the small blue flowers are normally insect-pollinated, but on dull days they close and self-pollinate when the stamens touch the stigmas.



Butterbur

Towards the end of April, after the flowers of butterbur have withered, the enormous leaves appear and the reason for the plant's name become clear. It probably derives from the practice of using the leaves to wrap butter. But although the leaves are remarkable, sometimes reaching one metre (3ft) in diameter and often smothering large areas of swampy ground, the flowers are even more interesting.

The butterbur belongs to the daisy family (Compositae) and, like the common daisy, its rather complicated-looking flower head is composed of clusters of small flowers. Each daisy flower head contains male and female parts in the individual flowers; but in most British butterburs the female parts are missing and the plants are therefore unable to produce fruit.

In a few counties—Lancashire, Yorkshire, Cheshire and Derbyshire—butterburs with differently structured flowers also occur. The inflorescences on these plants are composed of mostly female flowers which are fertilised by pollen from the male flowers of nearby plants. The pappus hairs around the fruits help in their dispersal.

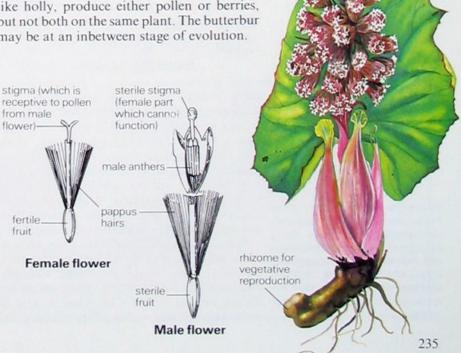
Why are female butterburs so restricted in their distribution, and why should this species contain two different types of plant?

The answer to the first question may be

that male and female plants differ in their requirements. The males may be more adaptable and therefore have managed to colonise a larger area of Britain than their female counterparts.

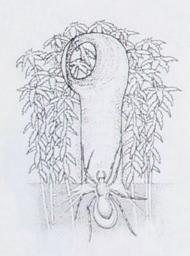
The answer to the second question seems to be more complex. Many plants have evolved systems of separating the male and female flowering parts to ensure crosspollination. Some plants such as the hazel have both flowers on the same plant. Others, like holly, produce either pollen or berries, but not both on the same plant. The butterbur may be at an inbetween stage of evolution.

Butterbur (Petasites hybridus). Male and female flowers appear March-May in damp meadows, woodland and beside streams. Female plant only found in Lancs, Yorks, Cheshire, Derbyshire. Ht 150cm (60in).





Above: A lycosid spider carrying a cocoon. In spite of the size of her burden, the female seems to be able to trundle about in search of prey without difficulty.



Above: The marsh spider, Pirata piscatorius, builds a vertical silk tube among sphagnum moss. It emerges to catch prey from the open upper end of the tube, and shelters underwater at the lower end among the moss stems.

THE HUNTER AND THE HUNTED

Wolf spiders are active hunters, preying on insects and sucking their juices for food. In turn, they themselves fall victim to small spiderhunting wasps.

Some insects, and other arthropods, are fierce predators which hunt down creatures smaller or weaker than themselves for food. This is not always a one-way system, however. Some of these hunters are themselves attacked by equally ferocious predators. The lives of wolf spiders and spider-hunting wasps (pompilids) cross in this way: the spiders prey on small insects such as flies and are in turn preyed on by the wasps.

Speed and surprise Wolf or hunting spiders catch prey not with a web like our familiar garden spiders, but by the speed, strength and surprise of their attack. They run down chosen victims in much the same way as a wolf-hence their name. They belong to

two families, the Lycosidae and the Pisauridae; in Britain there are nearly 40 species of the first and just three of the second. Most of these spiders are a drab brown or grey colour and can be distinguished from other spiders (mostly web-spinners) by the pattern of their eight eyes. These are arranged in three rows—four eyes in the front row and two in each of the other rows. Most wolf spiders are 5-10mm $\begin{pmatrix} \frac{1}{4} - \frac{1}{2} \ln \end{pmatrix}$ long, and even the largest never reach more than 20mm $\begin{pmatrix} \frac{3}{4} \ln \end{pmatrix}$.

Wolf spiders are ground hunters and frequent woodland, meadows, heathland and marshland. Some are associated with specialised habitats, such as the swamp spider, Dolomedes fimbriatus, or our five Trochosa species which favour heathland and live under stones or heather, only coming out to search for prey after dark. Our two most numerous species, Pardosa amentata and P. pullata, occur almost everywhere.

The keen sight of the wolf spider enables it to spot moving prey from a distance of a metre (3ft) or more. It lurks in the undergrowth, then rushes out to chase and overpower the victim with a bite from its fangs. Some species, such as the pale-bodied, dark-ringed *Arctosa perita*, dig a burrow in the ground to hide in, and pounce on victims as they pass by.

Mating and breeding Courtship among wolf spiders is carried out by means of visual signals. A male in mating condition stands in front of a female and waves his long palps as if sending a message by semaphore. Some species wave the front legs, while others vibrate the whole body. The female faces the signalling male and repeats his movements to indicate that she is ready to mate. At the end of this display, the male climbs on top of the female and injects into the genital opening of the female the sperm that he has previously transferred to a special organ at the tip of each palp.

The female spider lays her eggs on a silk mat and wraps them up in more silk to make a round cocoon. A lycosid female attaches the cocoon to the tip of her abdomen, while a pisaurid carries it, held up by her fangs and supported by strands of silk, beneath her body. The newly-emerged lycosid spiderlings clamber straight on to their mother's back and are carried around for several weeks until they disperse. In contrast, a female pisaurid detaches her cocoon before the spiderlings emerge and spins a sheet of silk over it. The young spiders remain in this nursery tent, with their mother on guard, until they are able to fend for themselves.

Small but deadly Wolf spiders are hunted by female solitary wasps-the spider hunters. To attack and overcome a large hunting spider is quite a feat, but these tiny wasps -such as the red-and-black-banded Anoplius fuscus and the grey Pompilius plumbeus-are able to sting the spiders and paralyse them with their venom. The thin-waisted wasps can curve their abdomen round the spiders and sting them on the more vulnerable underparts. The female pompilid catches spiders-particularly Arctosa and Trochosa-during the summer, to feed her future young. After mating, the female wasp searches among the undergrowth for a spider. Her excitable behaviour as she rushes about with wings quivering makes her very noticeable. Once caught, spiders are quickly immobilised. It seems that the spiders-panic-stricken by the colour, scent and lunging, darting behaviour of the attacking wasp-make little or no attempt to fight back.

The wasp carefully hides its paralysed



prey, sometimes in a shallow grave, while she digs a nesting burrow in the soil with her legs and jaws. Her long legs are equipped with stout bristles and spurs which help in raking the earth. When the burrow is complete—it consists of a straight or slightly curving shaft with a cell at the bottom—the wasp hauls the spider into it, dragging it backwards down the hole. All this hard work is not always rewarded, however. Since the wasp hunts first, then digs the nest, there is a period during which her prey is left unguarded. Many wasps return to the prey repeatedly while digging, but even so it may be stolen, often by other hunting wasps.

Paralysed provender When the spider is in position at the bottom of the burrow, the wasp lays a single egg on it, then seals up the opening of the nest with earth. When one nest is complete she repeats the whole procedure for the next egg, laying 10 or more eggs a season.

The egg hatches in two to three weeks and the larval wasp feeds on the spider which, in many cases, is still living but in a state of helpless paralysis. Having fed up on the meal provided, the larva develops into a pupa and overwinters in this form, emerging as an adult the following spring. Some *Anoplius* species hibernate in adult form.

Young lycosid spiderlings travel on their mother's back until they are old enough to fend for themselves. They descend by scrambling down their mother's legs, then run up tall grasses or other foliage. At the top each youngster rises into the air, attached to a long strand of silk and is carried along on the wind. This-called ballooning-helps the young spiders to disperse, they may be carried only a few metres, or several miles. Once they land, they start their own life of hunting.

Deadly attacker

Anoplius fuscus is the commonest pompilid wasp on sandy soils in southern England, but is rare in the north and does not occur in Ireland.

Females, already fertilised from mating the previous summer, emerge in April and start nesting almost at once. They hunt by sight and smell and usually manage to immobilize their chosen victim with one well-aimed sting.



Female spider-hunting wasp, Anoplius fuscus.

Anoplius fuscus searches among stones or vegetation until it encounters a spider. At this stage the wasp's antennae are highly curled.



Anoplius fuscus curves its abdomen right under the spider so that its sting can reach the vulnerable underparts and penetrate easily. At the same time, the wasp flutters its wings

rapidly.

RICH BUT THREATENED WORLD OF DOWNLAND

Chalk grasslands, boasting some 60 exclusive flowering plants as well as a fascinating range of insects, have become one of our most threatened habitats. In Wiltshire alone more than 64,000 acres were ploughed up between 1937 and 1971. Such disturbance ruins the diversity of downland plant life.

Chalk hills with their short, springy, thymescented turf, skylarks overhead and sweeping views over the smooth-contoured slopes to the clay vales below are the epitome of what most people think of as downland.

Limestone rocks outcrop over much of the British Isles and the Chalk is the most extensive and recently formed of the four major limestone formations. It is a soft white limestone laid down in the Cretaceous period some 135 to 65 million years ago and now exposed in a great arc from the Yorkshire Wolds to the Dorset Downs. In much of the Wolds and East Anglia it is overlain by glacial and other more recent deposits and most of the flatter land is under arable cultivation. In the Chilterns there are steeper escarpments with thinner superficial deposits bearing more typical downland scenery. The outcrop passes through the Berkshire Downs to the great chalk massif of Salisbury Plain and the other Wiltshire uplands. The Chalk extends eastwards along the North and South Downs, which culminate at the Channel coast as the white cliffs of Dover and Beachy Head.

Limestones are sedimentary rocks (originally part of the seabed) formed largely from the shells and skeletons of marine invertebrates. Fossils of shell fish, sea urchins, corals and microscopic planktonic animals and plants are common in them. The species represented are those of clear shallow seas and, in the absence of sandy or muddy inflows, the sediments formed consist almost entirely of calcium carbonate. The landforms, soils, vegetation, and even to some extent the animals of downland and other limestone country, all owe their characteristic nature to this unique purity of chemical rock composition (chalk usually consists of from 95% to 99% calcium carbonate) and to its properties.

No surface water Calcium carbonate is only slightly soluble in pure water, but much more so in weak acids. Rainwater that has absorbed carbon dioxide from the atmosphere is an acid solution, so chalk is easily dissolved by rain. Water also passes directly into the permeable rock, or through it in

channels, faults and joints, leaving none at the surface. Downland is therefore mostly devoid of ponds and lakes or streams, with much of its drainage underground.

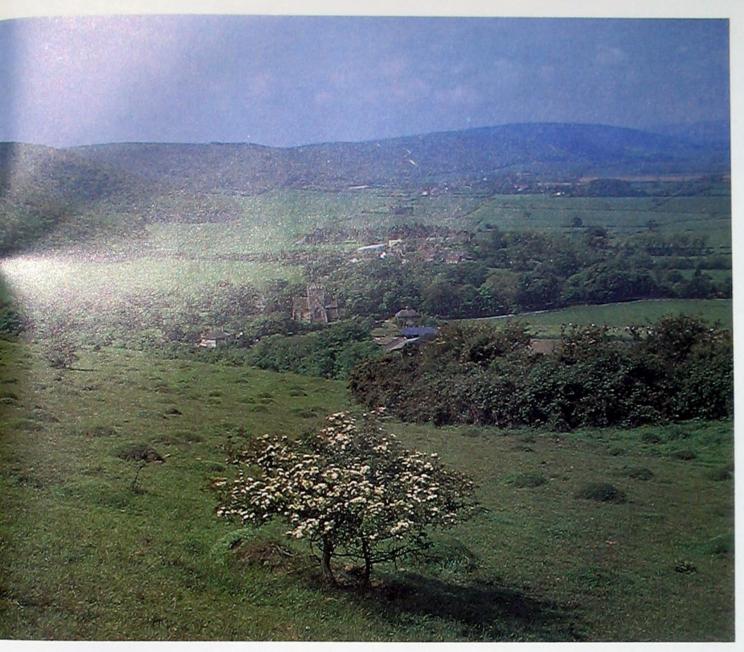
In the past the lack of water made it difficult for shepherds to graze sheep, so they made dew ponds; these were recharged by condensation from the atmosphere. To keep the pond and its water cool, the shepherds insulated it from the heat-retaining ground with a thick layer of straw. They mixed clay with water and then trampled on it, spreading this wet clay over the straw to keep the water in.

True downland soils are very thin and made up almost exclusively of black or greyish organic plant and animal remains. When the land is ploughed they can disappear almost entirely, leaving sparkling white fields where the chalk bedrock just below is exposed.

Abundance of flowers The short thick grass (sward) of chalk downs contains one of the richest associations of flowering plants found in the British Isles. In a close-grazed patch a metre or so square you might find as many







Above: The village of Poynings nestles in a valley between the chalk hills of the South Downs in Sussex. The hill in the foreground, close-grazed by sheep, is covered with ant hills. The yellow field ants build these domes on chalk grasslands, and the domes sometimes survive for centuries. Wild thyme often thrives on these dry hillocks.

There are few wildlife spectacles more impressive than drifts of silvery blue butterflies flitting in the summer sun over chalk hills. The chalkhill blue is on the wing in July and August. This one is resting on a greater knapweed flower.

as 30 or 40 species. Most of these species are plants other than grasses and in some places the sward is so dominated by these rosette, trailing and cushion plants that the word grassland is almost a misnomer.

The great diversity of species in chalk grasslands is made possible by the absence of limiting factors such as toxic elements to which only a few species have become adapted (as is the case, for example, in acid heathlands). Also, the infertility of the soil prevents vigorous species getting the upper hand.

But how do these lime-loving plants (calcicoles) of the downlands avoid competing with one another? In fact, what seems superficially to be a rather uniform environment is not; nor do all the species exploit it in the same way. Over 90% of chalk grassland plants are perennials, but of very different kinds. Some, like the orchids and dropwort, overwinter underground as tubers; others, such as rock-roses and thymes, are dwarf evergreen woody shrubs. Some, like squinancywort and lady's bedstraw, are trailing plants

and others, like dwarf thistle and plantains, are rosette plants.

These different perennial growth forms make different demands on the environment, as do the few annuals such as fairy flax and yellow-wort and biennials such as autumn gentian. The various kinds of plants have different flowering times, amounts of seeds, times of germination and germination needs. Bare soil, for example, is particularly important to the annuals and biennials. Many of the perennials are surprisingly long-lived, maybe up to 100 years. But their differing flowering times, from the spring orchids to the autumn gentians, and individual kinds of seed production suggest that they probably have quite different cycles of regeneration, even if their demands on the environment as mature plants may be somewhat similar.

Invertebrate life The great diversity of downland plants is reflected in a considerable range of invertebrates, for many of them, particularly the insects, have specific food plant needs. Many of the butterflies and



moths of downland are rare elsewhere for this reason. The chalkhill blue butterfly is perhaps, more than any other species, the symbol of the southern downlands. The food plant of its caterpillars (and of the rarer adonis blue) is the horseshoe vetch, a strict calcicole, so the butterfly, like its food plant, is confined to downlands. The larvae of the brown argus butterfly—also grouped with the 'blues'—feed almost exclusively on the rock-rose.

Most remarkable of all this group of closely related blue butterflies is the large blue. Its caterpillar first feeds on wild thyme, but is then taken by ants into their nests, where they milk it for a secretion it produces; the caterpillar in turn feeds on ant larvae. Wild thyme is not restricted to downland, but the limestone hills of the Cotswolds were one of the strongholds of the large blue before it began to become extremely rare, if not extinct. Its disappearance was caused by changes in, and loss of, habitat.

Some of the other characteristic butterflies and moths of downland also occur more widely wherever their food plants grow. The large and silver-spotted skippers and the marbled white feed on fescue and other grasses, while the six-spot burnet moth favours vetches and clovers, especially bird's-foot-trefoil.

The need for calcium Some invertebrates are even more directly tied to chalky soils than these butterflies and moths. Earthworms require calcium and are thus much more common in alkaline than acid soils, though they are only frequent in the deeper downland soils. Snails need calcium for their shells and are likewise common on chalky soils, particularly the banded snails.

The larger animals of downland are less diverse than the invertebrates and less confined to it. Small mammals, such as short-tailed field voles and the common and lesser shrews, which are widely distributed in all kinds of grassland, are also common on downland, particularly in the taller grasses and open scrub. They form a main food source for stoats and weasels, and also kestrels, perhaps the typical downland bird.

Above: Glow-worms form part of the chalk downland foodchain. Their larvae feed on snails, which thrive on chalky soils, by injecting them with digestive juices, then sucking up the remains. The adults, shown here, hardly feed at all.

At one time, when there were vast unbroken tracts of grassland on the southern downlands, other large birds such as the Montagu's harrier, stone curlew and great bustard were also found there. But the harrier and stone curlew are now very rare and the bustard became extinct in Britain as a breeding bird.

Skylarks, meadowpipits and wheatears all nest on downland and feed on the abundant supply of seeds and invertebrates. Wheatears are now more common in the north, but they were once so common on the South Downs that shepherds found it a profitable sideline to trap them in the abandoned rabbit burrows that wheatears use for nesting. They sold them as a delicacy on the south coast.

The absence of water from downland means that amphibians like frogs, toads and newts are rare, as are grass snakes which prey on them. But most of our reptiles, such as slow worms and common lizards, which need warmth to become active, thrive on the dry, warm downland slopes.

This article continues in issue 13.





Above: This colourful patch of chalk grassland in Hampshire contains a mixture of grasses, pyramidal orchids, oxeye daisies, lady's bedstraw and the dandelion look-alike, hawkbit.

Left: The velvety flowers of the bee orchid look strikingly like bumble bees. Occasionally a male bee mistakes the flower for a female and lands on it, so becoming dusted with pollen. In this way it aids the orchid's pollination.